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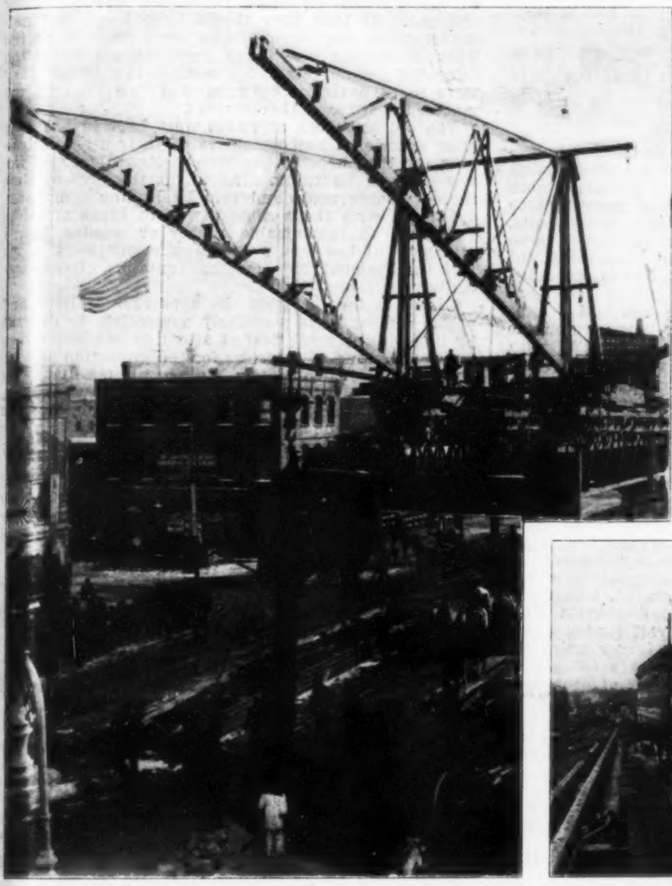
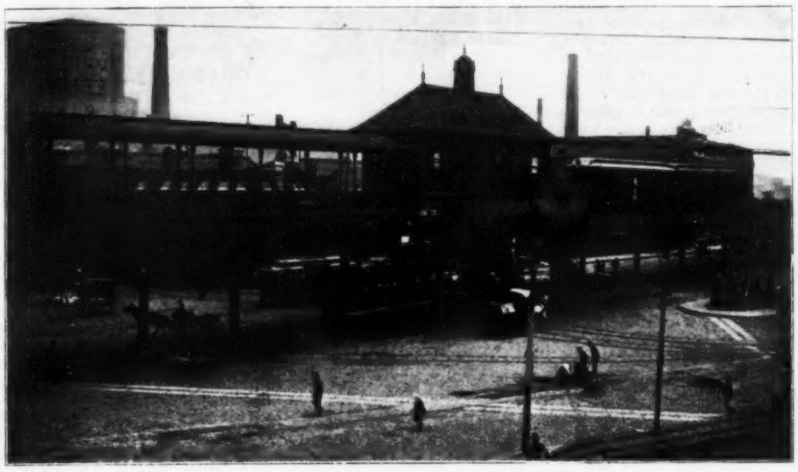


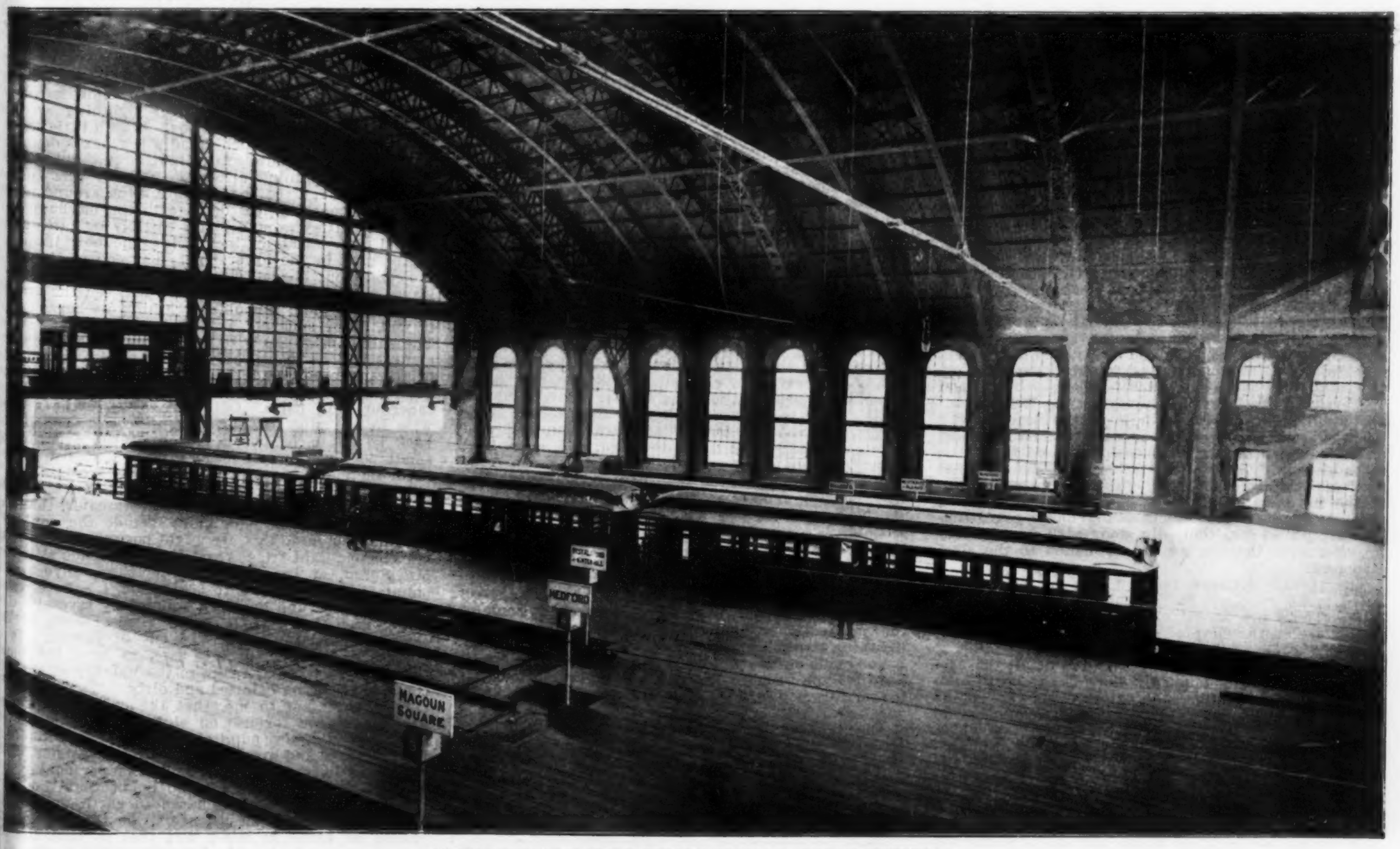
CONSTRUCTION OF ATLANTIC AVENUE CIRCUIT.



CITY SQUARE STATION, CHARLESTOWN.

SULLIVAN SQUARE STATION.

STATE STREET STATION—ATLANTIC AVENUE CIRCUIT.



INTERIOR OF SULLIVAN SQUARE STATION—NORTH TERMINAL.

BOSTON'S NEW ELEVATED RAILROAD.

THE BOSTON ELEVATED RAILWAY.

By J. A. Stewart.

The recent opening of the Atlantic Avenue circuit of the Boston Elevated Railway marks another step forward in the development of rapid transit in that city—a development which is going on speedily, and is attracting wide attention because of the unique and original methods adopted to meet the needs of urban transportation.

The Boston Elevated system is aptly termed unique in the solidity of the track structure, the perfection of the safety appliances, the speed of the train service, the convenience of its stations, and in the combination of overhead and underground features. Nowhere else in the country does one find surface cars running to the level of the elevated; and down a grade to enter a subterranean avenue. The purpose in the whole design is that the elevated may be run as an express system, the surface lines acting as feeders.

That this purpose is realized is shown by the fact that while the average speed on the Sixth Avenue line of the Manhattan Elevated road is 11.5 miles an hour, on the Boston Elevated it is 15 miles for the whole system, and on the Atlantic Avenue circuit 20 miles. On the run from City Square to Sullivan Square, trains sometimes attain a speed of over 40 miles an hour.

This speed is made possible by the elaborate safety appliances. In addition to a very heavy track provided with safeguards to prevent the derailment of cars, there are the block signal system, intended to keep trains a certain distance apart at all times and to prevent collisions, and automatic devices for stopping a train, should a motorman forget and run by a danger signal, and for shutting off the power if the motorman should become disabled.

The speed is accomplished in spite of the fact that the elevated trains must descend and pass through a subterranean avenue not designed for the use of express trains.

The heavy curvature of the subway is appreciated from the statement made by one of the officials of the road that a train is turned entirely around or doubles on itself over nine times in every round trip. The longest straight piece of track is less than 0.28 mile. There are ascending grades of 5 per cent, or 264 feet per mile, and there is one descending grade of 8 per cent, or 422 feet per mile. The billowy route from Boylston to Pleasant Street has been technically described as follows: "Descent is made down an 8 per cent grade, around a sharp reverse curve, without connecting tangent, around other curves, and over a hanging grade, ascending 4.5 per cent, descending 3 per cent, ascending 2.9 per cent, descending 3 per cent, ascending 5 per cent, then finally descending 1.5 per cent to Pleasant Street station." Small wonder that the subway has been the cause of the chief difficulties with which the management has had to deal and that the outcome will probably be a special subway for the exclusive use of the elevated system.

It was in order to avoid the erection of an elevated structure in the busy and crowded streets at the heart of Boston that the subway was utilized, and in connection with it the system of elevated roads was laid out which is now entirely completed from Dudley Street, Roxbury, northerly through the city proper with the subway as a conduit to Sullivan Square, Charlestown. This system included the loop on the easterly side of the city via Atlantic Avenue, passing the new South Terminal along the water front by the ferries and steamboat lines. The entire distance traversed is 4.9 miles through the subway and 5.4 miles via Atlantic Avenue. The passenger may ride from end to end of the Elevated by means of the Atlantic Avenue division without entering the subway.

The opening of the Atlantic Avenue circuit has added greatly to the efficiency of the elevated. To traverse the easterly loop the passenger going north changes cars at the Pleasant Street station at the south terminus of the subway. At this point an Atlantic Avenue train may be taken either north bound or south bound, the trip in the former case requiring 19 minutes and in the latter case 6 minutes.

The structure on the Atlantic Avenue circuit has the same distinguishing features which mark the construction in other parts of the system. An idea of its solidity is gained from Mr. George Kimball, the road's chief engineer, who gives a concise description: "The Elevated structure is built of steel, and the design for the most part is what is known as the open web or lattice girder. It is supported on steel posts, most of which are 15 inches square. In the narrow streets the structure spans the roadway with the posts on the edge of the sidewalk, while in the wide streets the posts are set in the roadway on either side of the surface tracks. The foundations for the posts are of concrete. They begin about ten feet below the surface and average about nine feet square at the base, gradually diminishing in size to the cast iron bases. Near the water front most of the concrete foundations rest on piles, which are driven into the ground for a distance of from twenty to fifty feet. On the longitudinal steel girders are placed the cross ties, to which are spiked the steel rails with steel guard rails bolted to them on all sharp curves. Then four large guard timbers are placed longitudinally along each track, which together with the ties are firmly bolted to the steel structure."

The average distance between stations on the Elevated is 0.6 mile and in the subway one-fourth of a mile. There are in all eighteen stations, of which twelve are on the elevated portion and six in the subway.

The most interesting and suggestive of all the Elevated stations is undoubtedly that at the north—the Sullivan Square station—the exterior and interior of which are shown in the illustrations. In dimensions and scope it rivals a great railway terminal, which in fact it is. The structure is a harmonious combination of red brick with sandstone trimmings; and the interior is of white enameled brick. It has three stories and a basement, the building occupying the whole block bounded by Main, West, Alford and Beacham streets, Charlestown, and covering an area of over 50,000 square feet. Fronting on Main Street are stores rented for business purposes. The first floor is given over to the local and cross-town surface lines.

There are ten tracks for surface cars, five on each side of the track on which the elevated trains are operated. The station is airy and light. An arch roof 62 feet high with a width of 175 feet spans the tracks. There are ample waiting rooms, finished in polished oak, with all conveniences. Suites of offices for the superintendents of both Elevated and surface divisions make the building a practical headquarters for the administration of the entire system.

The extent of the Boston Elevated Railway—including the central "express" division of the Elevated structure and all its feeders from every point of the compass—is appreciated when it is realized that it already consists of about seven miles of elevated structure equipped with third rail and 100 box cars; and 370 miles of leased surface tracks equipped with overhead trolley, with 1,538 box electric cars and 1,442 open electric cars. The system serves twelve municipalities, a population of about one million people, and carried over 200,000,000 passengers last year.

10 Millmont Street, Boston, Mass.

THE PROTECTION OF FIRE AND POLICE TELEGRAPH SYSTEMS FROM HIGH-TENSION CURRENTS AND LIGHTNING.*

By Walter M. Petty.

It is with considerable trepidation that I have undertaken the task of preparing a paper for presentation before gentlemen, many of whom have had much more experience than I with the subject of protection to fire and police telegraph lines and instruments. Believing, however, that the primary purpose of these papers is to provoke discussion and thus bring out individual opinions and experiences, I have proceeded with that object in view.

You will, therefore, pardon me if you find I have not contributed anything new to the literature on the subject, but have contented myself principally with descriptions, etc., of the apparatus at present in use by not only fire and police telegraph departments, but all others who have instruments and apparatus liable to injury from high-tension currents and lightning, such as telegraph and telephone companies.

Before proceeding further, let us examine the conditions under which we are laboring and just what is necessary for their protection.

Given, a pole line with wires used for various purposes upon it. This is a condition we often meet, especially in the smaller cities and towns. Let us say we have, as in the system under my control, an electric light circuit of 2,400 volts alternating, a telephone circuit, potentials not of moment, unless the wires cross with the aforementioned electric light wires; also, in some places, a 500-volt trolley power circuit. In addition to this in the larger cities the wires are underground, and perhaps overhead as well, necessitating cable boxes and some sort of protection at the point where the two are joined. At many points on the lines are the boxes; in most instances these are grounded at the outer case. Inside of these are magnets, etc., liable to injury from foreign currents. At headquarters and other points on the lines, are more instruments made to operate under currents of very small volume, and therefore liable to injury if subjected to anything exceeding their normal capacity.

Such injury may come from various sources; such as lighting, crosses with high-tension circuits, etc. We will consider the danger from lightning first. There is one point I wish to emphasize, and that is, that few circuits are damaged by direct lightning strokes. Let me quote from Mr. Alex. Jay Wurts, in his paper read before the American Institute of Electrical Engineers, in 1894: "I have been led to believe that in many cases, electric circuits become statically charged by contact with the neighboring charged atmosphere; that is, by conduction from it. The charge on the line, no doubt, leaks to earth, so does the charge in the atmosphere, but the two are maintained at practically the same potential. The potential of the atmosphere surrounding the wires of overhead circuits is not high. At the top of Washington Monument the difference of potential between the atmosphere and the earth during thunder storms is about 3,000 volts. If, then, the potential of an aerial wire is the same as that of the atmosphere surrounding it, the immediate source of danger from the static strain will be inconsiderable. When, however, a lightning discharge occurs from the clouds, this charged condition of the wire becomes unbalanced, the atmosphere has been discharged and its potential has suddenly sunk to zero.

"The static charge on the wire having lost the support of the previously charged atmosphere, now seeks an equilibrium, and in so doing sets up electrical waves, which travel to the extremities of the system, or to points of great resistances, and are there reflected to other points, to be again reflected, and so on. At these points of great reflection there is an enormous strain and a consequent tendency to 'side flash,' so often causing damage to insulation, etc.

"There are other methods, however, by which circuits probably become charged, namely, by static induction from clouds and by dynamic induction from cloud discharges. It is probable that these also set up electrical surgings in the circuit. *I am also inclined to believe that although a line is seldom, if ever, struck by direct discharge* it occasionally becomes charged by some of the ramifications which are often seen to accompany a lightning stroke."

You will, no doubt, find that your own experiences have led you to more or less the same conclusions. It is therefore necessary to protect our circuits from these surgings.

The lightning arrester pure and simple, is nothing more or less than a convenient path or outlet from these charged lines to a point of lower or no potential, the earth. The simple and fundamental principle of arrester is some form of air gap with serrated or plain surfaces. The only changes made have been the addition of circuit interrupting or arc prohibiting features which the different currents employed have necessitated. The success or failure of lightning arresters in general can be attributed mainly to the successful or unsuccessful performance of the duties devolving upon these additional features.

The name, lightning arrester, is a misnomer. Woe betide the piece of apparatus that would attempt to "arrest" the lightning. Sometimes this attempt is made, but usually nothing is left of the apparatus. The name diverter would be much better, as this is the real function of all arresters—to divert or discharge to the earth the charge on the lines.

Prior to the general use of dynamo currents, with their practically unlimited powers back of them, the old "saw-tooth" lightning arrester was considered about all that was necessary to protect instruments from lightning. Of course, nothing was needed in the nature of a fuse, as no danger could arise of crosses with any lines carrying more currents than those the instruments were designed to operate under. With the advent of the dynamo all these conditions were radically changed. At least they should have been; but notwithstanding that rapid strides were made along the lines of lighting, etc., many years elapsed before the telegraph people came to recognize the danger they were in of having their apparatus destroyed by too much current from other sources.

The old saw-tooth arresters were kept in use long after experience had demonstrated their utter uselessness for the purpose they were designed for, as protectors from lightning. Indeed, at the present time there is being made and sold by leading companies, apparatus with these same saw-tooth brass arresters (mounted on inflammable rubber or wooden bases) attached. It has been a source of wonderment to me why the National Code does not contain a clause especially prohibiting their use.

Owing to the fact that the apparatus of light and power companies is peculiarly susceptible to damage by lightning, a great deal of attention has been given to the designing of arresters for the protection of such circuits and instruments. We are all familiar with the work of Messrs. Thompson, Wurts, Garton, Wirt, and others, in this direction. Especial attention has been given to the finding of the proper materials to use to prevent the destruction of the arrester itself; also to the proper spark gap to employ.

I could wish that the various manufacturers of arresters for telegraph and telephone circuits could have done more along these same lines. With a very few exceptions, carbon has been the substance used because of its non-arcing properties. My experience has been that carbon dust thrown off during a discharge, has been a source of considerable trouble and annoyance. I find that many to whom I have spoken on this subject have experienced the same trouble. In the description of the apparatus of some manufacturers, which I will give later on, you will see that an attempt is being made to remedy this defect.

One of the points about which there seems to be a great diversity of opinion is the proper distance to have between the ground plate and the line. Prof. Elihu Thomson says: "The striking distance in air, or the distance over which a spark or arc discharge can be formed, is itself very variable. When the terminals are polished balls, and the parts of the circuit discharging have some capacity, the spark is sharp and distinct; an arc or flame takes the place of the first spark and may continue indefinitely. It is important to note also, that the effect of heating the terminals is to increase the striking distance to a marked degree. Terminals between which an arc has been playing may become so heated that although they are far enough apart not to be crossed by a given potential when cool, the discharge easily renews itself, and does this repeatedly."

Perhaps the most difficult part of the fire and police telegraph systems to protect is the boxes. I am heartily in favor of the ideas of some of our fellow members in doing away entirely with the lightning arrester and ground connection in the box. After a little experience in this line, in which I had a few boxes damaged by current from the electric light circuit presumably following a lightning discharge into my line and so to earth through the boxes, melting the ground plates and doing more or less damage to the mechanism, I disconnected my ground plates entirely by cutting the ground pipe about an inch below the box, inserting a pipe plug in the lower hole. The end of this plug projects about one-half inch below the box and thus leaves a gap of about a half inch between the ground pipe and the plug. Should a lightning discharge occur it will be of sufficient potential to jump this space. The only damage likely to be done under these circumstances will be to probably weld the wire to the side of the outer box, and the mechanism will escape, as none of the effects of the discharge will reach the inner or vital parts. Of course, I leave the ground wire in the pipe for purposes of testing, bending it back so as to be out of reach of the ever-present small boy, who would otherwise be tempted to use it for the many purposes the small boy can think of.

I am also in favor of making the shunts in the boxes of carrying capacity as great, if not greater, than the outside line wire. This must include the contacts; and in order to do this, we might borrow an idea from our electric light friends and use knife-blade switches. Mr. Suren, of the Gamewell Company, advocates a shunt in the ratio of 1 to 500. This, I believe, is an excellent idea, and has been adopted by several cities. Better even than this, is the so-called absolute cut-out—switching the box entirely out of circuit. It is necessary, however, in this case, to have the boxes inspected very often, owing to the liability of the idle contacts becoming oxidized and dirty.

It would seem to me, that the ordinary form of arresters, made for use on electric light and power circuits, would serve admirably the purpose of diverters for the boxes and overhead lines of our systems. Just how many to employ, I am unable from personal experience to state, but there is no doubt that the more opportunities for the discharge to earth outside we provide, the better off we are. One thing, however, should be borne in mind, and that is, that the air gap or gaps to be employed should be sufficiently wide as to preclude the possibility of a dynamic current

* A paper read at the Sixth Annual Convention of the International Association of Municipal Electricians at Niagara Falls, N. Y., September 2, 3, and 4, 1901.

leaping it and grounding the line. The experiments of the gentlemen before alluded to, especially Mr. Wurts, have shown that it is possible to construct arresters that will discharge the lines with little, if any, damage to themselves.

The styles and operation of instruments for headquarters might properly be taken up under the discussion of protectors, as they are of necessity parts of the same apparatus.

The trouble caused by crosses with high tension lighting or power circuits is a serious one. A suitable protector must be one that will provide an easy path to earth for the static discharge of lighting, and must be provided with a fuse or other device, capable of satisfactorily handling any discharge occasioned by a cross with a lighting or power circuit; and further, the device must be so sensitive that it will operate in case of a partial cross resulting in the establishment of minute or so-called sneak currents, which in time will destroy the apparatus if not interrupted.

There is, apparently, no one instrument made which will perform all these duties. The practice of most people who have instruments to protect, is to use a combination of elements, each one having a specific duty to perform. The fundamental ideas entering into these protectors are, first, as an interruption to currents of large volume, a fuse, of comparatively large capacity, inserted into the circuit as near to the entrance to the building as possible. Second, as a defense against currents of too small volume to operate the large capacity fuse but of high potential, a lightning arrester composed of brass or carbon plates separated by some arbitrary air space determined by the potential of the discharge liable to occur; one of these plates being connected with the line and the other to the earth. Third, for defense against foreign currents which are of too small volume to operate the large capacity fuse or too low tension to be shunted to earth by the arrester, is a heat coil which is operated by the temperature resulting from very small currents in such a manner as to open the circuit, or to shunt the current to earth.

There are also on the market a number of devices which depend for their operation on the use of a magnet of low resistance, inoperative under the ordinary currents used for telegraphing work, but which will be energized sufficiently to attract the armature should there be any increase in the volume of current over the normal. The act of attracting the armature releases a trip, which opens the circuit. These latter instruments are in reality circuit-breakers.

The number of fires resulting from the arc occurring upon the rupture of a fuse wire have caused the various manufacturers to put upon the market what are known as inclosed fuses. These are much more reliable than the older forms of open fuses. Any fuse left for a length of time in the open air becomes coated with an oxide, which may seriously affect the carrying capacity of the fuse. It is, therefore, not only desirable for purpose of protection to surrounding inflammable material, but for the fuse itself, to have it inclosed in some non-conducting, non-inflammable substance.

So much has recently been said and published on the subject of inclosed fuses, that I deem it unnecessary to enter into an extended discussion in a paper of this kind.

Suffice it to say, that there are now on the market several forms of inclosed fuses that can be relied upon to blow at very near their rated capacity.

When dealing with instruments designed for currents of such small volume as we use, an accurate fuse is very necessary. In the larger cities, where the manual systems are used and where operators are constantly on duty, the problem of protection is not so difficult to handle, as there, when a fuse blows or a protector opens it is known at once, and can be replaced; but in the smaller towns, again taking my system as an instance, the question as to proper instruments to use becomes a serious one.

Just what capacity of fuse to use is also part of the problem. I am inclined to the use of greater capacity than most people with whom I have conversed, and must say that my experience has borne me out. At one time I tried a five-tenth ampere sneak-coil fuse, and found it caused considerable trouble, blowing out when apparently no occasion required it. Since adopting at my bell tower, and other places, a higher capacity fuse, I have had no trouble, although I have had crosses with high-tension lines. This fuse has invariably blown when the occasion demanded it, and I have not lost an instrument since its adoption.

The main point which must be ever borne in mind in a fire alarm system, where lives and valuable property are often at stake, is the operation of such an alarm system at all times. "Every chain is as weak as its weakest link," and, to my mind, the weakest links of our systems are the fuses; it being impossible at all times to keep watch of them. You will agree with me, then, I am sure, when I say that in smaller systems it is better to over-fuse than to under-fuse, and run the risk of having the circuit left open until one can locate the trouble and replace the fuse.

Owing to the fact that several disastrous fires have occurred in telephone exchanges, a good deal of work has been done toward proper protection of telephone switchboards, and the American Bell Telephone Company, the parent of the telephone interests, has done considerable experimenting in order to determine the best styles and designs to adopt, not only for the central exchanges, but for the subscribers' instruments as well. Because of the extreme delicacy of the instruments used, the devices for their protection must be even more sensitive than those necessary for telegraph lines and apparatus.

I have seen it stated that a current of one-tenth of an ampere flowing for a short length of time would damage the coils of a telephone receiver. An authority on the subject of telephone protection, Mr. William J. Doolittle, says as follows: "A fuse as a detector of a protector against sneak-currents is practically worthless, for the fuse wire will heat to a glow, allowing a continual flow of enough current to heat and burn the delicate apparatus employed in telephone work. Practice has demonstrated that it is not the lightning discharges nor high-tension currents that are the greater menace to telephone properties, but it is the low-tension sneak-current. It is a known fact that a fuse wire in itself is not a protection against either lightning or high-tension currents. It is true at times it is operated by both currents, but the unreliability of a fuse lies in the fact that it cannot be tested, for when it is tested to its full carrying capacity it is destroyed; hence the carrying capacity is estimated by the gage of the fuse. A fuse in connection with a pair of carbons, whose surfaces are separated by mica or silk .0005 inch thick, makes a positive form of protection against lightning and a fair protection against strong currents, but an unreliable one against sneak-currents."

He also says: "A series of elaborate experiments has determined that a thickness of .0055 of an inch will be sufficiently small to cause the protector to operate at a difference of potential of 350 volts between the carbon plates."

The device furnished by the Bell Company to its sub-companies is composed of the three elements mentioned before as being necessary to properly protect. First, a fuse of from two to five amperes capacity, surrounded by asbestos braid and placed in a fiber tube. Second, the so-called arrester part of the device is a pair of blocks of gas carbon, one of which is connected to the line and the other to the earth, but they are separated by a sheet of perforated mica of such thickness that a current whose tension is less than that used by a trolley railroad will instantaneously leap across this space at the perforations and be conducted to the earth rather than to enter the telephone apparatus. Buttons of flexible alloy melting at 165 deg. F. are inserted in the faces of the carbon blocks, and the slightest warming, resulting from the continuous maintenance of the foreign currents crossing the space between the carbons will cause the alloy to flow into the intervening space and establish a permanent connection of lower resistance to the earth. In many instances the increased flow of current resulting from the diminished resistance is sufficient to blow the tubular fuse and open the line. Third, the sneak-coil, which is designed to operate under currents of too low a tension to be shunted to earth by the arrester, and which will open the circuit or shunt the foreign current to earth, according to the specific form of telephone apparatus to which it is applied.

Somewhat similar in its operation is the device made by the Sterling Electric Company. In one of their forms they use, embedded in the cavity between the blocks of carbon, a small shot held in place by soft wax. The function of this shot is to ground the line when the discharge takes place between the blocks of carbon, the resulting heating causing the wax to melt and release the shot. The sneak-current arresters consist of heat coils, which on operating open the circuit and release springs, cutting in the ground connection.

The Rolfe protector consists of a pair of heat cartridges, so-called, and holders thereof, and a couple of carbon blocks, placed so as to rest on a block connected to ground. When an excessively high current comes in over the line, one or both of the holders will automatically spring away from its terminal, or jump out, and thereby make one or two wide gaps in the circuit, and put in a ground, if desired. The "heat cartridge" consists of two shells of thin copper, soldered together with easily fusible solder, in which is placed a small pencil of carbon or graphite, of suitable resistance, copper-plated at each end to make good electrical contact. The heat cartridge remains cold at normal current, and when excessive current passes to the line the heat collected by the cartridge melts the fusible solder, releases strong steel springs, which cause the holders to jump out, and so open the circuit. These cartridges are made to operate from one-tenth ampere up.

The D. & W. Fuse Company supply a device consisting of an inclosed fuse, "non-arcing," capacity two amperes, and a sneak-coil fuse which they claim will operate at its rated capacity in fifteen seconds. It is entirely inclosed in a fiber shell about one and one-half inches long, and is provided with terminals so as to be readily inserted in the circuit. The arrester part of their protectors is interesting, being somewhat of a departure from the ordinary carbon type. Instead of carbon blocks they use chemically treated paper films inclosed in metallic casings. They claim that this film possesses the peculiar property of being apparently permanently grounded to all static discharges with voltage as low as 150 volts, while at the same time it will successfully stand up under a dynamic current as high as 550 volts. Further, that this device will permit small static discharges to take place as many as fifty times before it will break down under a dynamic current of the potential named.

The idea of this device is that it permits the ready discharge to earth of the small discharges which occur during thunder-storms, and at the same time prevents the earthing of the dynamic current except where the potential is quite high. Should the dynamic current be of sufficient high voltage to go to earth, the paper film chars out in a short time and grounds the circuit. Any extended flow will then blow the fuse and thus completely open the line. The resistance of the two ampere fuse is .05 ohm, and of the sneak-coil 1.22 ohms.

A protector, very much used by fire-alarm people, is the W. B. G. fuse and Argus arrester. The fuse device is claimed to be very accurate, and being mounted as it is on a porcelain base, either with or without a cover, is readily renewable. The Argus arrester consists of a porcelain base having two grooved sections, around which a bare wire of low resistance is wound spirally, and a ground plate of brass adjacent to the entire length of the coil and separated from it by an air space. The coil, it is claimed, acts as a choke coil, forcing the lightning discharge from the spiral wire to the ground plate, disrupting it into a great number of points, without grounding or disabling the line; a highly important feature where, as in fire-alarm and police telegraph work, a clear circuit under all conditions is necessary.

Another protector, and one much used in connection with the Argus arrester and W. B. G. sneak-fuses, is the well-known Plush protector. This is of the magnetic type, depending for its action on the increase in current over the normal in a low resistance magnet, causing it to attract an armature and so releasing an arm which opens the circuit.

There are other devices on the market; in fact, their name is legion; but I believe that I have described the principal features of all in the few spoken of, and any further description would be superfluous.

The experience and methods of one of the large telegraph companies, the Postal, is interesting, and I give it as a good example of modern methods of protection.

For terminal offices, such as New York, Chicago, Philadelphia, Boston, Baltimore, etc., the wires are first brought to six-inch ten ampere fuses, placed as near the entrance of the wires in the building as possible. These fuses are of the inclosed type, mounted on porcelain. From these fuses the wires are connected to lightning arresters, the ground plate being separated from the line plate by 100 mils thickness of perforated mica. The wires then pass on to another six-inch inclosed fuse of one-half ampere capacity, and from this are connected through the switchboard to the instruments, etc.

In intermediate offices, the wires are brought in from the poles to twenty-ampere inclosed fuses, thence to a lightning arrester with mica plates 100 mils thick, and thence to the switchboard.

You will note that no sneak-current fuses are employed at the intermediate offices. It is considered unnecessary in these places to employ sensitive fuses or arresters, the offices being closed from early in the evening until seven or eight o'clock in the morning, and having fireproof switchboards, it is impossible for the wires from the east to carry more current than the wires from the west can conduct out again. The only danger is from high-tension foreign currents or lightning, and as there is one-tenth of an inch distance between the line plates and the ground, there is no possibility of anything under 6,000 volts establishing a ground circuit. In such an event the ten-ampere fuse would undoubtedly open the circuit.

They have, through experience, been compelled to employ two fuses in the same wire entering a terminal office where they heretofore only had one fuse.

So far as their own currents and apparatus are concerned, there is no necessity for fuses in the wires, as the artificial German silver resistance, which is introduced in all battery circuits, prohibits any abnormal currents. But they are frequently invaded by foreign currents of all voltages, from one up to over 6,000, and from a few milliamperes to as many as the outside lines will carry without melting.

At one time the distance between the line plates and the ground plates was only five mils of perforated mica, but Mr. F. W. Jones, the electrical engineer of the company, informs me that this was too close, and frequently caused trouble, so they compromised by making the distance one-tenth of an inch of perforated mica.

In the submarine cables at river crossings, the fuses are made more sensitive in order to protect the dielectric from being pierced by lightning. The mica plates in these arresters are only ten mils in thickness.

Of all the devices on the market, none is perfect nor anywhere near perfection. It behooves us, therefore, to be ever on the lookout for improved devices, and at these meetings to discuss them, and if one is found answering the purpose better than those in use, to adopt it. This, I take it, is the fundamental idea of our association: to bring out by discussion, etc., the needs of the members, and to introduce to them the very latest and best apparatus, so that at all times our systems may be kept to the highest standard.

CONTEMPORARY ELECTRICAL SCIENCE.*

SELENIUM EXPERIMENTS.—J. W. Giltay describes some instructive experiments for demonstrating and studying the photo-electric properties of selenium. In the first of these a selenium cell of Shelford Bidwell's pattern is mounted in a drum resembling a fluoroscope, and the intermittent illumination produces a tone of corresponding pitch in a telephone put in circuit with the selenium cell. In another experiment the lid is removed from an ordinary Siemens telephone, and a monometric box substituted for it. The telephone is joined with a small induction coil and a microphone in the usual manner. On speaking into the microphone, the monometric flame, which is an acetylene flame, is thrown into corresponding vibrations which, acting upon the selenium cell, produce changes of resistance, and these are re-converted into sound by a telephone inserted in a circuit containing the selenium cell. The third experiment is even more interesting. The selenium cell is inclosed in a box with three small incandescent lamps connected in series, and inserted in the secondary circuit of an induction coil. The primary circuit contains a carbon microphone. On speaking into the latter the lamps, which are fed by 16 accumulators, exhibit variations of luminosity corresponding with the sound vibrations, and these are re-translated into sound by the selenium cell.—J. W. Giltay, Physikal. Zeitschr., August 24, 1901.

ELECTRO-CHEMICAL MICROSCOPY.—R. Kohn suggests a new method of research, specially applicable to plant physiology. It consists in producing gold deposits under the microscope by means of the electrolysis of a thin superficial layer of gold chloride. He proves that all vegetable cells show P. D.'s which regularly appear in the course of the cellular activity. All plants are pervaded by a connected system of electric conductors whose conductivity is many times higher than the conductivity of their insulating surroundings. These conductors are identical with Schimper's *Leitscheiden*. It is not clear whether they should be classed as metallic or as electrolytic conductors, but the greatest probability speaks for the latter. The solution of starch at the top cells and its deposition in an insoluble form at the root is equivalent to an electrolytic transmission, a kind of telegraphic transmission of

* Compiled by E. E. Fournier d'Albe in The Electrician.

carbo-hydrates. The chief conductor lies to the right and left of the mid-rib of the leaf, and is two cells deep.—R. Kohn, Pamphlet, Mercy, Prag, 1901.

FOUR-MOTOR EQUIPMENTS.

The development of electric railroad service and its extension from short, low-speed lines with small traffic in crowded city streets to long, high-speed, interurban and suburban lines carrying heavy traffic has brought about the general adoption of longer and heavier cars mounted on double trucks in place of the single-truck cars or comparatively light double-truck cars formerly used. Greater speed is usually required of the larger cars, and to meet the strains imposed by this greater speed and the larger live loads, they are made much more substantial and strong, and consequently proportionally heavier than the older types.

The increase in weight of the cars necessitates a corresponding increase of the motive power equipment. The increase in speed necessitates a lower gear ratio, thus requiring a further increase in the motive power equipment to give the same tractive effort. The high schedule speed combined with the frequent stops usually made by electric cars necessitates much more rapid acceleration than that needed under the old conditions, thus causing a third increase of the motive power equipment. For these reasons the necessary power of the motors approaches, and in many cases exceeds, the amount that can be obtained conveniently with two motors under the usual limitations of gage, truck wheel base, and height of car body. The rapid acceleration necessary to make a fast schedule with frequent stops requires an adhesion closely approaching the maximum obtainable with only four wheels driving. While the weight on the drivers of a double-truck car equipped with two motors will, on a good rail, give sufficient adhesion for as great an acceleration as is comfortable for the passengers, slippery rails, snow or ice, the breakdown of one motor, the addition of a trailer or the necessity of pushing a crippled car, will so reduce the acceleration as to make a car so equipped fall far behind its schedule time on a long run.

For this reason and for others given below, many electric railroad companies prefer to use four motors per car, thus making the motors of moderate size, every wheel a driving wheel and all weight available for adhesion, and providing ample tractive effort under all conditions.

It is of interest to calculate exactly the difference in weight on drivers between a two-motor and a four-motor equipment with the same weight of body, load and truck, and with motors aggregating the same rated horse power in the two cases. For this calculation we will assume that the weight of the car body and passengers and the double trucks without motors is 18 tons and that the equipment in the one case will consist of two GE-73 motors, which are rated at 75 H. P. each, and in the other case of four GE-67 motors rated at 38 H. P. each, thus giving 150 H. P. to the car in either case. With centrally pivoted trucks the weight of the car body is equally divided between all wheels. With both motors on one truck all weight of motors comes on drivers. For the two-motor equipment the weight on the drivers is therefore about as follows:

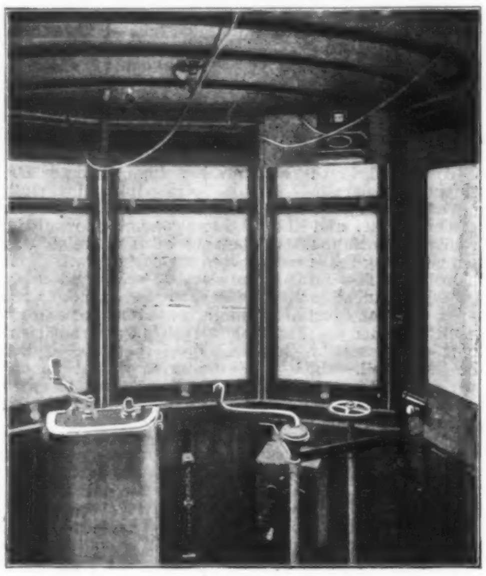
One-half of the weight of car and trucks	18000	pounds.
Weight of two motors (3.665 pounds each)	7330	"
Total weight available for adhesion	25330	"
No. of driving wheels	4	
Weight on each driving wheel	6332	pounds.
Total weight of car body, trucks and motors	43330	"
Ratio of weight on drivers to total weight	58	per cent.

It should be noted that on a truck with a 6-foot wheel base, if one motor is put on each truck, and is underhung, the weight of a GE-73 motor is divided between the driving and the idle wheels in the ratio of about 4 to 1. This gives an even smaller percentage of total weight on drivers.

If a GE-67 four-motor equipment were substituted for the two GE-73 motors the weight on the drivers would be as follows:

Total weight of car body and trucks	36000	pounds.
Weight of four motors (2,100 pounds each)	8400	"
Total weight available for adhesion	44400	"
No. of driving wheels	8	
Weight on each driving wheel	5550	pounds.
Ratio of weight on drivers to total weight	100	per cent.

From these figures it will be seen that the weight available for adhesion is increased more than 20,000 pounds by using a four-motor equipment, the ratio of the weight on the drivers to the total weight being almost doubled, while the total weight of the equipment is increased by only about 1,000 pounds or slightly over two per cent, and the maximum weight per wheel is reduced nearly 800 pounds. With this great increase of weight available for adhesion, the schedule speed can be maintained and lost time may be made up by extra rapid acceleration, no matter what may be the condition of the rails. While the greater weight available for adhesion may not be necessary under ordinary conditions, it is of value on heavy grades or when bucking snow or running on a slippery rail. If one of the four motors breaks down it is possible to cut out two motors and still provide a tractive effort approximately equal to that of a two-motor equipment in good condition, which will enable the car to be brought to the repair shop on a reasonably good schedule and without blocking the



VESTIBULE OF CAR WITH FOUR-MOTOR EQUIPMENT, MILWAUKEE ELECTRIC RAILWAY AND LIGHT COMPANY.

rest of the road. If one motor of a two-motor equipment on a double-truck car breaks down, the weight on the remaining drivers falls to less than 30 per cent of the total weight, cutting down the speed below schedule and hence delaying traffic on the road.

On the score of relative efficiency, two large motors appear preferable to four smaller ones, the GE-73, for instance, having a maximum efficiency of about 87 per cent, while that of the GE-67 is 84 per cent. The slight difference in the power consumption due to this cause is usually more than made up by the greater economy due to the more rapid acceleration obtainable with the four-motor equipment.

CURRENT CONSUMPTION.

The almost universal opinion of those who have used two-motor and four-motor equipments is that the four-motor equipments consume considerably more power than the two-motor equipments, the increase in current consumption being estimated all the way from 10 per cent to 50 per cent. The four-motor equipments, undoubtedly, do take as much more power as their owners estimate, but this power is not wasted by motor inefficiency, for if it were, the four-motor equipments would promptly burn out. The true explanation of the increased current consumption is the fact that the four-motor equipments do more work than the two-motor equipments. Assuming that the weight of cars, the schedule time, and the number of stops are the same with both equipments, and that both equipments are geared to the same speed, the four-motor equipments are better able to make their schedule under adverse conditions, and to make up lost time when necessary, and the motormen invariably make use of this reserve ability when the occasion demands, thus requiring the motors to do more work and necessarily consuming more electrical power.

On a slippery track, or during snow, ice or sleet storms, or at times when the car is badly overcrowded and has to make long stops at each corner or stopping place, the two-motor car is unable to accelerate rapidly and run at high speeds between stops and thus maintain its schedule, while the four-motor car, by virtue of its greater adhesion and tractive effort, can get up to speed promptly and run at high speeds, even on a bad rail with frequent stops. Naturally, under these conditions the comparatively lower adhesion of the two-motor car limits the current to less than that of its stronger rival, but the cost of the extra power consumed by the four-motor car is much more than repaid by the better service.

The assumptions as to equality of car weights, schedule speeds, number of stops and gearing in the two cases are, however, rarely borne out by the facts. Even if the weight of the cars in the two cases and the speed to which the two equipments are geared are the same, the four-motor equipment soon demonstrates its ability to make the schedule more quickly than the two-motor equipment, and the number of stops on a given run is allowed to increase without an increase of the schedule time, or if there is no demand for an increased number of stops, the schedule time is slightly cut down. A slight increase of schedule speed with the same number of stops, or a slight increase of the number of stops with the same schedule speed must increase considerably the energy input of the car.

When a change is made from a two-motor equipment to a four-motor equipment, the weight of the car is generally increased somewhat, on the ground that four motors per car will carry more weight without overtaxing them. As a rule also, the speed to which the equipment is geared is increased somewhat on the same ground. Either or both of these changes naturally increase the amount of energy consumed by the car.

If there is no difference between car weight, schedule speed, number of stops, or gearing with the two-motor and four-motor equipments, the latter should take but slightly increased current, due to the lower efficiency of the smaller motors. With two GE-73 motors and four GE-67 motors in the same service, the latter should take about 3 per cent more current than the former, since when geared to the same full load speed four GE-67 motors will produce the same tractive effort as two GE-73 motors with about 3 per cent more current throughout the full range of operation.

If the four-motor equipment is found to take materially more current than the two-motor equipment, the service performed by both being the same in all respects, the explanation will probably be found in the fact that the four-motor equipment is better able to make a more rapid schedule, hence more time is wasted with the four-motor equipment in slow acceleration, running on the series point and slow braking, or longer waits on stops, thus naturally calling for more current to make the same schedule.

Often, however, the four-motor car will require less current than the two-motor car for exactly the same service, because its better adhesion and more rapid acceleration allows a greater amount of coasting, the latter being the greatest factor of relative economy between motors as well as between motormen.

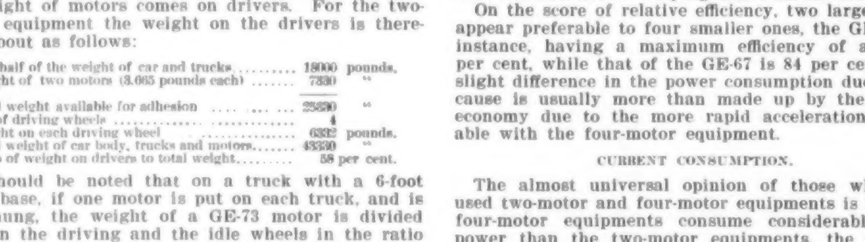
The heating of four motors will invariably be less than that of two motors, each of twice the rated power, running in the same service. This is due to the greater radiating surface of the four smaller motors which more than compensates for the greater losses which take place within them. Referring again to the same two sizes of motors compared above, the GE-73 has twice the commutating capacity of the GE-67 and has at rated load, on account of its greater efficiency, somewhat lower losses than two 67's, each with its own rated load, which is one-half that of the 73. As the 73 contains almost as much material as two 67's it will, with nearly the same losses, rise in temperature the same amount when run for one hour with the same load, since the rise of temperature during a one-hour run depends on the losses and the amount of material to be heated up, and is largely independent of the radiating surface. But in all-day service the temperature rise will depend on the amount of radiating surface, and, as this is considerably greater on the four 67's than on the two 73's, the former will run much cooler.

This accounts in part for the lower cost of maintenance of four-motor equipments. The harder a motor is worked and the more it is heated, the greater is the gradual charring effect on the insulation of both armature and field coils and the more frequent are the renewals and repairs of these parts. Frequently, also, when the four-motor equipments are substituted for two-motor, the four motors have a greater aggregate rated horse power than the two, that is, the change is from two heavily loaded motors to four moderately loaded, thus still further reducing the heating, lengthening the life, and reducing the cost of maintenance.

Other reasons for the preference of many street railway managers for four-motor equipments may be found. Among them the following arguments may be emphasized here.

Light motors are more easily handled, removed and replaced, than heavy motors, and this fact compensates for the increased number of motors in a four-motor equipment. As noted above, the GE-73 weighs complete 3,665 pounds, while the GE-67 weighs only 2,100 pounds. Comparing larger sizes, the GE-55, which is rated at 160 H. P., weighs 4,925 pounds, while the GE-73, four of which have the same horse power rating as two GE-55's, weighs 3,665 pounds.

Greater clearance can be obtained between the road bed and bottom of motor with a small motor than with a large one. Also, within certain limits, car bodies can be placed lower with small motors than with large, thus removing the objection of high steps. The GE-7



CAR WITH FOUR-MOTOR EQUIPMENT, INTERNATIONAL TRACTION COMPANY, BUFFALO, N. Y.

has a height over all of 29 inches while the GE-67 has only $25\frac{1}{4}$ inches, thus giving $3\frac{3}{4}$ inches more clearance between the track and the motor frame or between the motor frame and the car body with the latter motor than with the former.

The division of the equipment into four parts reduces the strain on gears, axles, bearings and trucks, thus diminishing the wear and tear of these parts. These equipments are made by the General Electric Company, Schenectady, N. Y.

WHEN TO USE A COLOR SCREEN.*

PERHAPS the greatest drawback in orthochromatic photography is the supposed necessity of using a screen in order to secure the desired effect. Now, it is true that, in order to render correctly the luminosity of objects, our plate must be sensitive to the light rays reaching it in proportion to their luminosity, but that is perfect orthochromatism, which (1) has not yet been attained, and (2) may not always be necessary or desirable. Let us, therefore, inquire as to when we should use a screen, and when we may dispense with it, contenting ourselves with something less than perfection of luminosity representation. We know the function of the screen—to depress or subdue the over-active blue rays; we know that the screen need not necessarily prevent us attempting even instantaneous work, though it increases the normal exposure from three to forty times. When can we do without it altogether?

The point is one about which there is considerable difference of opinion. Capt. Abney says that the screen is not necessary or desirable when photographing an outdoor scene with plenty of sunlight from a high sun, the sky being comparatively free from clouds, and the atmosphere clear. He continues:

If we take a negative of a landscape on a cloudy day, the light is of uniform quality, and screen or no screen will not matter. The results will be very closely identical. When we come to a sunset, however, we have different conditions. The high lights are illuminated by the sun and the sky. Now, in the orange light of a sunset there is very little blue light, and, as is well known, the most brilliant illumination of a setting sun fails to show itself on a plate without a screen, on this account. Practically all the photographically actinic light is high light and shadow is sky light. Place a yellow screen in front of the lens, however, and the whole aspect is changed. Considering the sunlight as all yellow, we get on an unscreened plate a ratio of high light and shadow of five to half, or ten to one, and, the yellow screen inserted, it is seventy to one. The effect of the sunlight would, therefore, be shown in the last case, but not in the first. It must not be assumed that the above proportions of yellow to blue represent the facts entirely, but they are sufficient to argue upon. Any of these legitimate factors would lead to the same results.

If we want cloud effects the use of the yellow screen at all times is useful, for while from the clouds it allows the yellow contained in the sunlight to pass, it only leaves a small amount in the blue sky. The consequence is that the white cloud will be much better delineated when the screen is used than without it. When we have a blue distance the yellow screen is a very useful adjunct to insure its absence.

Charles Ehrman says: When the sun is low, or the light of a yellow color, a screen will not only be useless, but absolutely disadvantageous. The light acts as the screen, dispensing with its use in the same manner as in copying oil paintings by a yellow light, where a screen is also dispensed with. It is obvious, therefore, that the use of a screen in photographing landscapes must be left to the judgment of the photographer. It may be said, however, that it is very rarely necessary, and in almost every case orthochromatic plate used alone will, by its increased sensibility to yellow or red, give a far better effect and a more truthful color rendering than an ordinary plate; and this, of course, is more and more apparent the larger the amount of yellow that is included in the picture. Thus, for instance, the effect is most apparent in photographing a woodland scene in autumn when the leaves are turning yellow, and in this state of affairs a screen is absolutely unnecessary. Indeed, its only effect would be to increase the exposure necessary. As we said before, the only occasion for the use of a color screen in landscape photography is when violet and blue rays have so pronounced an action upon the sensitive film that their representation in monochrome is out of all proportion to the effect of the color value as apparent to the eye. When used for landscape work the color of the screen should be of a very pale yellow. If too strong, it is liable to give an exaggerated effect —that is to say, the distant parts of a landscape would appear too sharply defined; they would lose all effect of distance imparted to them by the mistiness that lends aërial perspective to the view.

G. T. Harris says: When the photographer is compelled to work in dull weather, with overcast sky, the use of yellow filters aids enormously in getting results superior to those obtainable with ordinary plates. The greens are brightened up, and the distance rendered clearer to such an extent that a landscape photographed with a deep filter under a dull, heavy atmosphere will often have the appearance of having been taken in good diffused light. This fact alone should make the use of orthochromatic plates and light-filters commendable to the professional photographer, who, indeed, seems the most persistent in ignoring their aid. Another direction in which filters, and notably deep ones, become extremely valuable in the work of the professional photographer, is in photographing buildings in large towns, where smoke, haze, and congested thoroughfares make it almost impossible to obtain good results when working in the ordinary manner. The shadows are covered with gray haze, and the exposure has not been quick enough to avoid movement in the traffic, nor sufficiently prolonged to obliterate it altogether. But, use an orthochromatic plate and a deep enough filter to clear away the haze, the long exposure necessary under these conditions quite obliterates the effects of the traffic, and the result is a photograph with clear shadows and an absence of blurred figures in the foreground.

In landscapes with clouds the light-yellow screen may be used; where clouds alone are photographed a deeper tint will be advantageous, and a slow rather than a rapid orthochromatic plate is to be preferred. In this case an exposure of from one-tenth to one-quarter of a second will be about right. Of course, it will be readily understood that with lenses of large aperture, such as the anastigmats, we can use a rapid orthochromatic plate and a yellow screen fairly full in tint, without a much longer exposure than would be required with a lens working at $f/8$ and a slow orthochromatic plate with light screen or no screen at all. Where this can be taken advantage of, the rendering of luminosity values will necessarily be better. With regard to the different cloud forms, some being strongly defined and others having more delicate values, it is obvious that a screen of deeper tint is required for the latter, while a light screen will suffice for heavier forms.

* From Wilson's Photographic Magazine.

THE BURSTING OF FOWLING PIECES.

THIS article is not written to frighten hunters, but, on the contrary, to put them on their guard. Owing to the kindness of M. Jeandet, the well-known gunsmith of Lyons, we have, says La Nature, been able to take photographs of three gun barrels which, despite their perfect construction, burst last year under circumstances that are interesting to make public.

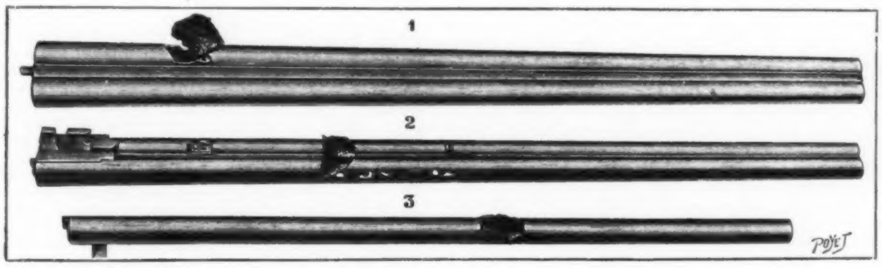


FIG. 1.—BURSTING OF GUN BARRELS.

The first hunter had fired a cartridge into which it had been forgotten to introduce powder. The priming alone, in exploding, had the force to drive to the middle of the barrel the wadding and the charge of lead, which had clogged up this part of the gun, without the hunter having any suspicion of it. Hence, when the gun was again fired it burst.

The second accident was caused by the introduction of clay into the end of the barrel at the moment of a fall and a neglect to examine the state of the gun thereafter. The clay formed a plug, and, when the gun was fired, caused the bursting of the barrel.

The third accident was more curious, and occurred in an extra strong gun. The hunter, who sometimes used a 12 and sometimes a 20 caliber, had upon his person cartridges for both. Having just fired with his 12 he carelessly reloaded with a 20-caliber cartridge. Upon pulling the trigger there was no response, and so he thought that the breech chamber was empty. He therefore introduced a 12-caliber cartridge into it and fired again. A bursting of the gun ensued, accompanied with serious results. The 20-caliber cartridge introduced at first had slid along the breech chamber and formed a wedge and blocked the lower part of the chamber by means of its copper flange.

At the moment of the deflagration of the 12-caliber cartridge the enormous resistance of the obstacle formed a rent in the barrel, notwithstanding the strength of the gun.

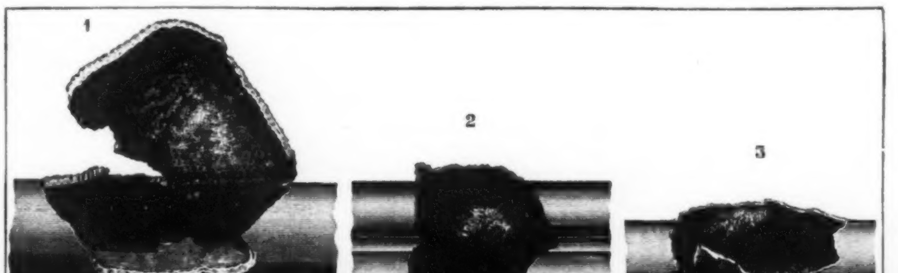


FIG. 2.—DETAILS OF THE RENTS IN GUN BARRELS.

WHY DOES MODERN LEATHER ROT?

IN discussing this problem The Literary Digest says that modern industrial processes, which have superseded older ones because they are swifter and cheaper, sometimes leave much to be desired in the way of results, especially in durability. That this is the case with paper has often been noted and lamented. That it is so also with leather has been asserted by an English committee of librarians who have been investigating lack of durability in book-binding; and the truth of the charge is acknowledged by The Leather Trades Review, the chief organ of the trade in Great Britain, which recognizes that the existence of many a manufacturer may be put in jeopardy by it. A summary of the findings of the committee, which is given with a running commentary in The Publishers' Circular (London, August 24), shows that many of the methods of tanning now in use produce an inferior leather and one that decays with speed. Says this journal:

"For long past there has been an outcry among the makers and users of books as to the bad quality of so much of the leather used in bindings. When publishers and others have complained to the binders, the reply has been to blame the leather merchant and the tanner. We are told that it is to modern scientific progress in the manufacture of leather as taught us by the Germans that is due the chief characteristic of most of the leather made nowadays, viz., the rapidity with which it rots; not only book leather, but boot leather, and leather used for straps, portmanteaux, etc., has lost most of its ancient fame for durability.

"The curious part of it is that the old methods of making leather which lasted for centuries are still known; the art cannot be quite extinct, since really good leather is still to be had if you know where to get it and will pay for it.

"Under the auspices of the Society of Arts a committee of librarians has been carrying out a series of experiments and investigations in order if possible to discover the cause of the rapid decay in modern book-binding leathers.

"Their report, which has recently been published, is pretty certain to do an immense deal of good, not only in restoring the durability of the leather bindings of our books, but in improving the quality of leather generally, at least of certain kinds of leather."

Referring to the admissions of The Leather Trades Review, noted above, The Circular goes on to say:

"It cannot be said that The Review is not candid as regards the shortcomings of modern leather, and, while suggesting that the binders are not without blame, it admits 'that there is ample justification for the general complaint that modern leather is not so durable as material turned out hundreds of years ago.' This sweeping and damnatory statement of fact refers to leather generally, and we may ask without impertinence whether the disappearance of those stacks of oak bark which we used to see all over the country is not intimately connected with the decline and fall in the once superlative quality of leather—viz., strength and durability.

"The most serious allegation brought by the committee against the tanner of binding leather seems to be the unsuitability of certain modern scientific tanning agents, which make leather quickly—much more quickly than the old-fashioned agents—but 'soon ripe soon rotten.' The use of certain mineral acids in the dyeing operation is said to hasten decay, as well as excessive 'shaving, straining, embossing, and glazing.' The committee urge, as proving their contention, that many of the older leathers which have had little of the finisher's art bestowed upon them are in a good state of preservation, although the books 'have been kept under precisely the same conditions as modern bindings, which are absolutely rotten.'

"The alarming statement is made that a book bound in Persian morocco or Persian sheep shows signs of decay in less than twelve months, and they unhesitatingly advise in all contracts for binding the use of East India tanned goat or sheep should be absolutely forbidden.

"It must have been somewhat humiliating for the organ of the 'International Leather Trades' Chemists' Association' to admit that it was left to a committee of librarians to discover that leather tanned with the catechol series of tanning agents, which include gambier, larch, quebracho, hemlock, and turwar bark, is particularly prone to decay. The importance of this may be gaged when it is remembered that millions of Indian sheep and goatskins which come over to England in the tanned state, and are finished and sold largely for book bindings, are 'tanned with this suspicious agent.' The committee are most emphatic on this point, as they say: 'For cheap bookbinding purposes this leather has been most extensively used, and in all their numerous investigations no leather has proved so inferior in resistance to decay as the re-tanned so-called Persian.' . . .

"Not content with telling the tanners how they should not tan leather, the committee have happily

been able to teach them how they should do it, and The Leather Trades' Review, in acknowledging this, says:

"'It is extremely useful to the leather manufacturer to find from the report referred to that the pyrogallol class of tannins, which include myrabolas and sumach, have been proved to yield leathers much more resistant to decay than the catechol series, and as they (the committee) strongly recommend pure sumach as the ideal tannage for bookbinding leather, it looks as if any change of methods will present little in the way of practical difficulty, as fortunately this tanning agent is cheap and its use well understood.'

"It was understood by the Moors hundreds of years ago."

SOLUBILITY OF SHELLAC IN ALKALINE SOLUTIONS.

As is well known, shellac dissolves very easily when heated in solutions of carbonate of potash or soda, of borax, of caustic soda or potash, or ammonia, and these solutions are used partly as "water varnishes," and partly for the manufacture of bleached shellac. In all these solutions the shellac remains unchanged, and dries to a hard coat, and can be precipitated out from them by acid. Benedikt and Ehrlich have already discovered that dilute alkalies convert a large part of shellac into a balsam-like mass, which they have named liquid shellac. To prepare this, shellac is first freed from wax by boiling in soda, and is then boiled into 300 grammes of caustic soda and 2 liters of water to every kilo. of shellac for two hours, water being added from time to time to replace that lost by evaporation. When the mass is cold it is acidulated with sulphuric acid and shaken up several times with ether. The ether is then distilled off from the solution of the resin. The residue consists of the liquid shellac, and the yield of it is about 70 per cent of the wax-free resin. By mixing liquid and ordinary shellac, plastic masses of any desired degree of softness can be obtained. The best way to prepare these mixtures is to divide some shellac into two parts, of relative magnitudes, which depend upon the degree of softness desired. One part is dissolved in solution of carbonate of soda, and the other is boiled as above directed with caustic soda. Both solutions are mixed when cold, the wax is removed, and the shellac is precipitated with acetic acid. On stirring, the precipitate forms lumps of plastic resin. If the two parts are about equal, the resulting mass can be kneaded with the fingers, but is not sticky, and can be drawn out into very thin threads or sheets. One gramme will give a thread upward of thirty meters in length. When the plastic shellac has been washed quite free from acid, it remains soft for months, and then only hardens gradually on the outside. It is purified by boiling for a long time with six times its weight of 70 per cent spirit, and an excess of calcined magnesia in a flask with an upward condenser, and then boiled up by mixing it with its own volume of water, and blowing in steam until all the alcohol has been driven off. The liquid is then filtered, and the residue on the filter is washed with cold water until the filtrate only gives a slight turbidity with hydrochloric acid. The filtrate contains all the liquid shellac as a magnesium salt. It is treated with dilute sulphuric acid, and shaken with ether, which is then decanted and distilled off. The residue of liquid shellac is dried at 100 deg. C. It is thick and tough, draws out into threads, and becomes thin when heated on the waterbath. It only dissolves very slightly in water, even on boiling, but is freely soluble in alcohol or ether. When heated, it gives off water, and forms a solid mass, having a conchoidal fracture, and closely resembling the original shellac.

The chemical composition of liquid shellac is the same as that of ordinary shellac. When shellac freed from wax is oxidized with permanganate in alkaline solution, azaleic acid is formed. 100 parts of the resin giving 20 of the acid. There are also formed products smelling like butyric acid, and liquid shellac is also formed. If the solution of permanganate is repeated as long as there is any unchanged resin, the whole of the shellac is ultimately converted into azaleic acid and fatty acids. The result confirms Preschern's theory, that the shellac-wax is closely related to ordinary fats. Benedikt and Ulzer have obtained ceryl and myricyl alcohols from shellac-wax. These alcohols appear to be combined in the wax, partly with fatty acids and partly with resin-acids. Such esters of resin-acids, with high terms of the monatomic alcohol series, are an entirely new discovery.—Farben Zeitung.

BARIUM PREPARATIONS.

THE wholesale manufacture of barium salts has largely increased of late years, and some account of the most approved modern methods will not be uninteresting. All of them are prepared from native heavyspar or barytes, and with most of them the heavyspar, which is sulphate of barium, is first converted into the sulphide by heating it with coal. The ovens for this purpose have two side doors, through which the mixture of heavyspar and coal, finely ground together, is charged in, and the final product is removed; 1,900 pounds of the mixture can be fully treated in about two hours. The glowing sulphide is then rapidly raked out into iron trucks, and these are provided with lids, which are at once closed to prevent oxidation. The trucks are then allowed to cool. The sulphide of barium must not only be kept from the air, but must be kept dry, as it is rapidly decomposed by water or steam. The yield of barium sulphide depends upon the percentage of sulphate in the heavyspar, and on proper management of the oven. Theoretically it should be 72½ per cent of the weight of the sulphate. A bright red heat is required.

The sulphide of barium is dissolved out from the charge withdrawn from the oven with hot water, which is run through several lots of stuff in succession till it is saturated. The lixiviation leaves behind coal, dirt, unchanged barium sulphate, and a little of the barium sulphide. The solution must be clear and of a pale yellow color.

There are three methods in vogue for manufacturing barium chloride; to heat a mixture of heavyspar, coal and calcium chloride, and to decompose either the carbonate or sulphide of barium with hydrochloric acid. The first is the commonest method. A mixture is made of 300 pounds heavyspar, 176 pounds chloride of calcium, and 120 pounds of coal, all ground fine together. The heavyspar must contain at least 95 per cent of barium sulphate. The same oven is used as for making barium sulphide, and the process should be complete in 2½ to 3 hours. The drawn charge should be gray, and of a uniform color, free from specks. The output should be 55 to 60 per cent of the total weight of the charge. The lixiviation is done exactly as with the sulphide. When the liquor has reached 22 deg. to 24 deg. B. it is treated with a stream of carbonic acid to decompose any sulphide of barium present, and throw it down as carbonate. The solution is then allowed to clear, and is run off to the crystallizing pans. The crystals are centrifuged, and the mother-liquors are mixed with a fresh charge for the oven.

When the chloride is made by treating the carbonate with hydrochloric acid, the carbonic acid evolved should be made useful, as it can be in a variety of ways. The same is true of the suphureted hydrogen evolved when barium chloride is made from the sulphide. Crystallization is in any case the final step in the manufacture of the chloride. The commonest use of the sulphureted hydrogen is to burn it to sulphurous acid for sulphuric acid chambers, but it can be used to make pigments, and in many other ways.

Blanc fixe, so much used in the pigment and paper trades, is artificial sulphate of barium. The natural sulphate is never white enough, nor will the artificial article be, unless great care has been taken in selecting the raw materials. The chloride of barium, perfectly free from iron and sulphur, is dissolved in water destitute of any contamination with iron or organic matter, and the solution is precipitated with dilute sulphuric acid. A cheaper process, which does not, however, give so pure a white, is to precipitate a solution of the sulphide of barium with one of sulphate of soda. The precipitate must be thoroughly washed after all sulphide of sodium has been removed from it with water. The washed precipitate is made into a 25 to 30 per cent paste in a filter press. The sulphide of sodium is crystallized for tanning and other purposes.

Carbonate of barium is made by precipitating sulphide of barium solution of 15 deg. B. with solution of carbonate of soda. The sodium sulphide is crystallized, and the barium carbonate is filter-pressed, exactly as in the making of blanc fixe. Another process of making the carbonate is to precipitate the barium sulphide solution by bubbling carbonic acid through it. The sulphureted hydrogen evolved is used in vitriol manufacture, as above described. The carbonate finds its chief uses in the glass trade, and in the manufacture of barium chloride and nitrate. The latter salt is in some factories made by decomposing the carbonate with dilute nitric acid and crystallizing the product, in others by mixing solutions of barium chloride and sodium nitrate and separating the barium nitrate from the common salt formed with it by crystallization. The nitrate is used for colored fires.

Barium hydrate is used in sugar refining. On a small scale it is usually made by acting on barium chloride by caustic soda, both in hot, strong solutions. The barium hydrate crystallizes when the mixture is cold, and is then washed with cold water. The barium hydrate is then recrystallized. Another method is to shake up solution of barium sulphide or zinc dust and zinc or copper oxide. The solution of baryta is filtered off from the heavy metallic sulphide and crystallized.—Oils, Colours and Drysalteries.

ETHER WAVE LENGTHS.

IN a lecture on "Wireless Telegraphy" delivered by Mr. S. M. Kintner, professor of electrical engineering in the Western University of Pennsylvania, before the Engineers' Society of Pittsburg on March 19 last, there was presented the following interesting table of ether wave lengths and vibration frequencies, producing the phenomena of heat, light and electricity:

Designation.	Wave Length.	Number of Vibrations per Second.
Flash of lightning	11,000 miles	17
Induction coil	18 miles	10,000
Pint Leyden jar	54 feet	18 millions
Large oscillator	1 foot	100 millions
Five-inch oscillator	7 inches	172 millions
Shortest electrical wave	2½ inches	480 millions
Lowest heat sensation	583 millionths of inch	20 trillions
Highest heat sensation	39 millionths of inch	300 trillions
Red light	271 ten mill'ths of in.	434 trillions
Orange light	258 ten mill'ths of in.	500 trillions
Yellow light	244 ten mill'ths of in.	520 trillions
Green light	207 ten mill'ths of in.	570 trillions
Blue light	191 ten mill'ths of in.	634 trillions
Indigo light	169 ten mill'ths of in.	680 trillions
Violet light	165 ten mill'ths of in.	740 trillions
Ultra-violet radiation	140–85 ten mill'ths of in.	870–1500 "
Roentgen rays	Unknown	Probably 300 quadrillions

Prof. Kintner remarks that the upper part of the table is that which is known as electrical, and for which Hertz supplied the first detector. "Next comes that which our sense of touch knows as heat. Following is light, of which we know through our sense of sight. Following this, the camera tells us of radiations much further, through the ultra-violet up to and including the X-rays.

"This table is not continuous, however, as we find several gaps in which the effects produced by these particular vibrations are unknown. First the magnetic wave from the sun has never been observed, but its length simply calculated from the conditions of the sun as an oscillator. The first waves we begin to observe are those due to lightning, and they can be followed on down until we arrive at the shortest one produced (up to the present), 2½ inches long. If we could continue to reduce the size of our oscillators we could get then to light; however, that would require bodies the size of an atom, and, unfortunately, we have no means of constructing such an oscillator at present.

"Following on down through the gap, we come upon a wave length producing what we call heat; after passing through a range of this, another gap, and then we come to light; after passing through the several colors we go again to the invisible, and depend upon the chemical action to take us farther. However, we soon arrive at its limits, and for the present we can go no farther. But is that the end? We have no reason to assume it."

SELENIUM.

IT is somewhat significant that in the Preliminary Report lately issued by the Royal Commission on Arsenic in Beer no mention is made of any possible part which selenium may have played in the tragedy enacted in the closing months of last year in the north of England. The position taken up by Dr. Tunnicliffe in this matter, although the analyses which he produced do not appear to have been disputed, has not, as far as we have been able to ascertain, gained the support of scientific opinion generally. At any rate, the prevailing impression seems to be that though it is possible that the selenium detected in some of the vitriol used in the manufacture of the brewing sugar may have aided in producing the subsequent disastrous effects, still the arsenic was the main factor in all the cases of illness, and undoubtedly the sole factor in a great many. Of course, it may turn out that the final report of the commissioners will contain references to points which it is considered advisable to keep quiet about until some necessary research has been conducted; and we certainly do not wish, on the present occasion, to take up any decided position one way or the other on the selenium question.

Some public prominence, however, having been attained by selenium in this connection, it seems of interest to say a word or two as to its occurrence and properties, as, to judge by the remarks we have heard, the very name was an unknown quantity to brewers and the public generally until it achieved its recent prominence in the daily press. A very brief summary is all that need be given here of facts which may be gleaned from any text-book on chemistry; our space will be more usefully occupied by references to such matters as are scattered far and wide in scientific literature, and which are not readily accessible. Selenium exists in two allotropic modifications—the one a black crystalline powder, and the other a brick-red powder. The black powder, or metallic selenium, is obtainable as a granular crystalline mass of 4.5 specific gravity. The original source from which it was obtained was the lead selenide found at Clausthal, in the Hartz Mountains, but a more plentiful and modern source is the Spanish pyrites used in the manufacture of oil of vitriol, and it is among the acid manufacturers that the properties and appearance of the element are best known; that is, as a matter of interest and not in the way of business, for the very small amount of selenium which finds employment in the arts does not act as an inducement to the vitriol maker to take up its preparation commercially.

The fact is that selenium remains to-day, as of yore, very much a substance of scientific interest, and cannot be classed among those elements which minister in any real capacity to man's needs. True, its peculiar electrical effects have been taken advantage of by Mr. Shelford Bidwell in the construction of the photophone, an instrument by which light is converted into electricity. But neither this nor the one other scientific application which we are aware of, viz., its employment in connection with certain astronomical instruments, can be taken as offering sufficient inducement for the acid manufacturer to take up its preparation on a commercial scale. An objection, by the way, has been taken by some scientists to the name as commonly used, because, although it is common to talk of metallic selenium, it is really a non-metallic element. For this reason the objectors say the termination "um," which is characteristic of the names of metals, is inappropriate, and should give way to "selenion." It is generally agreed that scientific nomenclature, having been left so much to the taste of individual discoverers, is in a somewhat chaotic condition, and could be overhauled and brought up to date with advantage. However, it is not a matter on which we are disposed to wax eloquent at the present time, and we shall be content with merely drawing attention to the fact that differences of opinion exist. Of course, in speaking of the application of this or that chemical substance for trade purposes, it is not possible to speak too exactly; a certain amount of reservation is always desirable on account of the secrecy which is observed in so many cases as to what chemicals really enter into particular manufactures. We are moved to say this because of the proposal which was made a year or two ago to use selenium as an agent in the production of red glass. Whether the proposal ever reached the subsequent stage of regular use we are unable to say, but a strong claim was made out in its favor; the use of selenium, both alone and in admixture with cadmium sulphide, obviating, it was said, the necessity of reheating and dipping in a coloring mixture in the ordinary process of making red glass. It was in the year 1885 that Dr. Divers, professor of chemistry at Tokio, pointed out that when seleniferous acid is used in the alkali manufacture the rare element passes over into the hydrochloric acid in the form of selenium seleno-chloride, which in contact with water decomposes into elemental selenium, selenious acid, and hydrochloric acid. This detection of selenium in Japanese vitriol is interesting, because presuming that the acid was made from local brimstone, it shows that whatever safety from arsenic may be experienced in the use of brimstone instead of pyritic acid, such procedure would prove delusive where freedom from selenium was aimed at. Although we are of opinion that, as far as the beer epidemic was concerned, the case against selenium was not made out, yet the fact that the acid made from some brands of brimstone, at any rate, contains selenium is one that should not be lost sight of. It may be mentioned in this connection that it is customary in pharmaceutical circles in America to test sulphur for selenium. The official test of the Pharmacopæia is to boil half a grain of sulphur with half a grain of potassium cyanide in water, to filter, and add excess of hydrochloric acid to the filtrate. In the presence of selenium a reddish coloration is obtained, the delicacy of the test extending, according to some authorities, to the detection of 1-500th of a grain. With regard to the toxic properties of selenium, although in the recent rise of the element into prominence many chemists pooh-poohed the idea that it would give rise to an

mischief in this way, the fact of the poisonous nature of the alkaline salts has been clearly established. With regard to this point attention may be directed to the work of Chabrié and Lapicque (Compt. Rend., page 110), the researches of those authors proving that sodium selenite is without doubt an irritant poison. A subsidiary point to which they draw attention is the harmlessness of sulphites as compared with selenites when injected into the system, on account of the immediate transformation of the former into sulphates. The fact is not without its importance, seeing how generally sulphurous acid and its compounds have come to be used in the brewing industry. As we have said, the present-day applications of selenium are neither extensive nor of the first importance, and the outlook for its increased use is not bright. No doubt if an increased demand arose, the present price of about 6 shillings per ounce would experience a reduction, as there is evidently no lack of raw material. As in the case of arsenic, the attention which has been drawn to the subject of this article has led to analytical investigations of interest and importance, the result of which has been to put the detection of these bodies in various food products on a secure basis.—Engineering.

THE MEASUREMENT OF SEDIMENT.

THE accumulation of sediment is one of the perplexing questions which the hydraulic engineer often has to solve; it meets him in many phases of his practice, and may even become so serious a factor as to jeopardize the success of large and costly operations.

Sediment bearing is a function incident to all streams. The gradual and universal, though extremely slow, degradation of the land, through the agency of storms and other natural phenomena, always has and always will lay upon the streams the burden of transporting to the sea the waste particles of earth which are washed down to them. But in so large and diversified a country as ours so many different conditions are found which affect the accumulation of sediment that it is exceedingly difficult to establish any rule by which this objectionable feature may be determined. The swiftness of current, the presence of forests, the cultivation of the soil, the aridity or humidity of the climate, the prevalence of violent storms, all have their modifying effects upon the amount of sediment to be found in streams, so that each locality and often each stream presents a different problem and must be studied by itself.

There are a number of ways in which sediment is an injury to engineering projects, not the least of which appears in connection with reservoirs and their maintenance. We are entering, some one has fitly said, upon the reservoir age, so important an economic factor has the storage of the energy of streams become. Never before has there been such activity shown in the construction of large and costly dams for the supply of cities, for the production of power and for the conservation of water for the purposes of irrigation. Evidence of this activity is found in the great Croton dam near the city of New York; the Wachusett dam, near Clinton, Mass.; the dam on the Susquehanna River to provide power for the extensive electric plant to be erected at Conowingo, Md., and that on the Yuba River, in California, besides a number of large projected works for irrigation in the West. With the investment of so much capital in enterprises of this nature it is of importance that their efficiency be kept at as high a mark as possible, in order that the expected balance between expenditures and earnings may be realized. The effect of sediment on the efficiency of reservoirs is well known. The dam which is intended to impound the water checks the flow of the stream by forming a cushion of still water athwart its course, and the load of sediment, which before was carried along by the force of the current, now gradually settles to the bottom. Here it accumulates, and, if no measures are taken to remove it, may in time so reduce the capacity of the reservoir as to seriously cripple its efficiency. An interesting example of the effect of too much sediment in a large reservoir is found in the case of the city reservoir at Austin, Texas, where, just before the collapse of the great dam in the spring of 1900, 48 per cent of the original storage capacity of the reservoir was found to be mud; this sediment had been accumulating for about seven years.

In view of the evil effects of sediment in operations of this character, the series of experiments conducted by the hydrographers of the United States Geological Survey to determine the amount of sediment carried in the waters of certain of the rivers of Arizona will be of general interest. The methods of investigation were as follows: By means of a small bottle attached to a hollow rod samples are taken from various parts of the stream and collected in a bucket. After thorough mixing the water in the bucket represents as nearly as possible the average condition of the water flowing in the stream. A measured quantity of this water, usually 100 cubic centimeters, is placed in a tubular graduate of glass divided into cubic centimeters. Ordinarily this is allowed twenty-four hours to settle, but if longer time is required for thorough settlement it is allowed. The clear liquid is then decanted and rejected, leaving a small quantity of water with the sediment in the bottom. If the amount of sediment is inconsiderable another sample is added, taken on the day following that on which the first sample was procured, and after settlement it is decanted in like manner, the process being repeated from day to day until a sufficient quantity of sediment has accumulated to make a reading on the scale of the glass graduate. Under ordinary conditions, when the stream is not in flood, it sometimes requires thirty days to accumulate samples which would show 2 or 3 cubic centimeters of sediment, but at times of flood a large quantity of sediment is sometimes obtained from a single sample of 100 cubic centimeters, in which case the quantity of sediment is ascertained by reading, and a new determination started on the following day. The total quantity of sediment obtained from the samples or series of samples is divided by the quantity of water used in the accumulation, and a ratio thus established which is applied to the total volume flowing in the river.

It was found that the mud obtained from these samples was of a very thin consistency and contracted greatly upon being dried. To determine the amount of this contraction a number of laboratory tests were made. The residue was dried at 100 deg. C., and the dried material was weighed, its specific gravity also being determined. As might be expected, the results of these tests were by no means uniform, but the mean of tests made indicated about one part of dry matter to five parts of mud, which factor has been used in reducing observations of this kind. In other words, it is assumed that after complete settlement the mud in the bottom of the water sample consists of one part of solid matter and four parts of water.

The foregoing method requires very little skill and time, and the apparatus used is extremely simple. The error of the determinations lies mainly in the assumption of the factor used in reducing the mud to solid matter, and it is probably considerable.

Another method which is now undergoing test is as follows: Samples of water are obtained in the manner already described, and a measured quantity is poured upon an ordinary filter paper in a funnel and is filtered as in the chemical laboratory. If the residue is inconsiderable the process is repeated until the measurable quantity of sediment is obtained, which is dried and afterward is weighed. The reduction is made in the same way as in the first method; that is, the quantity of water used is to the sediment obtained as the quantity of water flowing in the stream is to the quantity of silt carried in suspension.

This method, to be used with any considerable degree of accuracy, requires the use of a pair of delicate scales. The error of determination consists partly in the errors of observation, which would be greater than in the first method, unless great skill is employed in the filtering and weighing of the sediment, but chiefly in determining or assuming the specific gravity of the silt obtained, as it is volume and not weight that ordinarily is required. It is believed, however, that when the necessary instruments and skill are available it is much more accurate than the first method. These methods may be combined and used upon the same samples, thus becoming checks on each other.

Such investigations as these will materially assist in reducing to greater accuracy the knowledge of conditions to be met in projected enterprises which contemplate the use of the running streams.

The foregoing description of experiments in the determination of sediment is taken from a recent report, No. 47, of the "Water Supply Papers," of the Geological Survey, where the matter is discussed with greater fullness.—Bulletin No. 73. George B. Hollister, Resident Hydrographer, U. S. Geological Survey.

LIVERPOOL'S THREATENED RIVAL.

By CONSUL JAMES BOYLE.

WHAT is known as the Berehaven Harbor scheme was for a week or so a subject of unusual interest in Liverpool. When Parliament at the close of the recent session, without any preliminary notice, passed a bill giving authority for the construction of a pier and other shipping facilities at Berehaven, there was great consternation in Liverpool, particularly in view of the statement of the promoter of the bill that it was intended to establish a line of steamships which would make the journey from America to Berehaven in four and one-half days. Since the passing of the bill authorizing the harbor facilities referred to, there has been an exhaustive discussion in the press and privately among those interested in Liverpool shipping and commerce, and the general conclusion arrived at is that Liverpool has nothing to fear from the Berehaven scheme.

A reference to the map will readily show that Berehaven is admirably situated in a geographical sense as the eastern terminus of a trans-Atlantic line, but, in truth, the southwestern and western coasts of Ireland have a number of harbors much nearer America than Liverpool, capable of accommodating the largest ships afloat. For many years Bantry Bay, in which is Berehaven Harbor, has been a rendezvous for the British fleet, and it is admitted to be one of the safest and most commodious harbors in the world. The passage of the Berehaven Harbor scheme bill in Parliament has revived reminiscences of other schemes having for their object the shortening of the sea passage between Europe and America. Most of these plans had in view the utilization of one of the numerous natural harbors of the west or southwestern coast of Ireland as the eastern terminus. None of these projects, however, has ever passed beyond the experimental stage, and, so far as I can learn, the prospect is very remote that the Berehaven scheme will, at least for many years to come, become an actuality, and the probability is that it will meet the fate of its predecessors. After having had time to duly consider the possibilities of the new project, the shipping and commercial interests of Liverpool have come to the conclusion that even though Berehaven Harbor be completed as projected in the Parliamentary bill and the most up-to-date railroad connections be made, and even though the proposed rapid 25-knot fleet be established, yet after all Berehaven can be nothing more than a port of call, and at the most would take the place of Queenstown, en route to Liverpool. The reasons back of this conclusion seem to be sound, and may be stated briefly as follows:

1. The terminus of a steamship line should be within easy reach of the objective point of passengers. Berehaven does not meet this condition precedent. The objective point of most trans-Atlantic passengers is London or the Continent. In order to reach either point, passengers who disembark at Berehaven would have to make an additional change to cross the Irish Sea.

2. It is necessary for a terminus of a trans-Atlantic line, both on the European and American side, to be convenient for the rapid and cheap distribution of cargo. The population of Ireland, as compared with the rest of the British Isles, is small, and indeed decreasing and very little of American cargoes have Irish points as their ultimate destinations, and Ireland's exports to America are but small. The transshipment of cargo which would be necessary with Berehaven as the eastern steamship terminus seems to put that place out of the question.

3. As a trans-Atlantic shipping terminus, Berehaven would be under the great disadvantage of having to bring coal from a considerable distance (Wales being the nearest point); there would be lacking an ample supply of seamen from whom to select crews; and the commissariat would be much more costly than from, say, Southampton or Liverpool.

Possibly Berehaven might become a rival of Queenstown as a port of call, but even that is doubtful. Not only would several million dollars be required to construct the necessary piers and wharves at Berehaven, but the place at present is entirely lacking in railroad connection. The promoters of the Berehaven scheme bring forward, as against Queenstown as a port of call, the conceded objection that passengers have to reach shore from the ship by tender. It is true also that sometimes communication can not be had at Queenstown, when the weather is very rough, and accounts agree that Berehaven Harbor would be available at all times; but the Liverpool steamship people say that it is very doubtful whether it would pay in a commercial sense to adopt the Berehaven scheme, as against the present facilities at Queenstown, for the reason that, comparatively, but few passengers embark or disembark at Queenstown, and they argue that not many more would utilize Berehaven.

THE FUTURE OF THE TRANS-ATLANTIC TRADE.

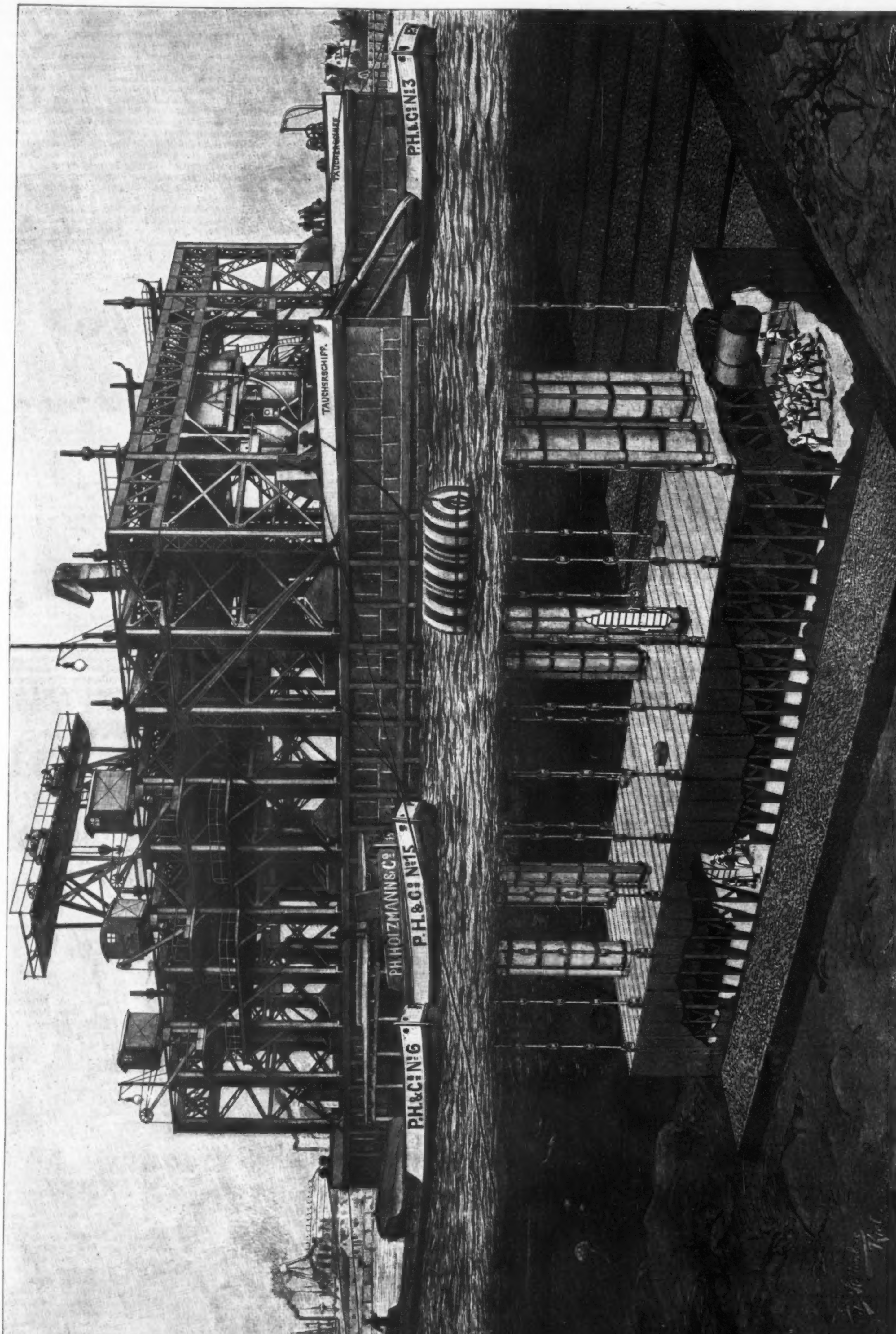
While Liverpool shipping and commercial interests do not fear that Berehaven, or any other port on the west or southwest coast of Ireland, can become a rival of Liverpool, there is much speculation and some uneasiness as to the future of the trans-Atlantic trade. In this connection, the press and the public seem to be more apprehensive than the managers of the steamship lines. There is undoubtedly in Liverpool a deep-seated popular fear that the British steamship lines—and reference is more particularly made to the Liverpool lines—may be outdone by American and German enterprise. A great deal of apprehension exists among the British public as to the possible competition through the inevitable development of the American mercantile marine; and there is keen disappointment at the failure so far of the Liverpool companies to wrest "the Atlantic blue ribbon" from Germany. Here one meets a sharply defined difference of views. The popular demand is for the construction of vessels that will not only excel in size the "Deutschland" and "Kaiser Wilhelm der Grosse," but also surpass them in speed. The Liverpool steamship managers profess to believe that under present conditions, the limit of speed has been practically reached, from the standpoint of commercial success. The claim is made that it would not pay to build faster ships than those now running between New York and Liverpool. The position of the Liverpool shipowners seems to be that at present the best policy is to build ships of large capacity and of only fairly great speed, and to await developments. Intimations are made that future competition will be duly met, and a keen watch is being kept on rival enterprises. It is very difficult to obtain reliable information as to the intentions of the large British shipowners, the policy of each company evidently being not to "show its hand." There are rumors that the Liverpool lines are awaiting the results of the experiments that are being made with the "turbine" system, and that if these prove successful vessels will be built for the Atlantic service of greater size and speed than any now sailing.

ELECTROMETALLURGY OF LEAD.

HOMOGENEOUS metallic lead is deposited from slightly acid concentrated solutions of lead nitrate or acetate, containing, for preference, considerable quantities of the corresponding alkali salts, by a current of about 0.024 ampere per square inch at the cathode. It appears that when an anode of lead is used, the electro-motive force is about 0.1 volt. When the conditions are such that lead hydroxide can be formed at the cathode, spongy lead is deposited. Concentrated solutions of lead or alkali salts dissolve considerable quantities of lead hydroxide; when such a solution is electrolyzed, the removal of lead from the layer of solution in contact with the cathode dilutes it. This more dilute solution deposits the lead hydroxide or basic lead salt which it contains on the cathode, and so prevents the regular deposition of the metal, giving rise to the spongy deposit. Lead chloride and sulphate give unsatisfactory results, owing largely to the formation of insoluble lead chloride or peroxide at the lead anode. By using very small current densities and electromotive force it is, however, possible to obtain coherent deposits. The deposition of lead may be utilized for plating objects with lead or for separating lead and silver, the alloy being used at anode in a solution of nitrate saturated with chloride; the silver remains behind undissolved. Coherent deposits of lead are also obtained, although with more difficulty, from alkaline solutions. The concentration of the lead ions is so small in these solutions that the liquid surrounding the cathode soon becomes so impoverished that the electro-motive force rises, and the next available cathion (an alkali metal) is discharged. This results in the secondary reduction of lead sponge. By keeping the electro-motive force low, and replacing the liquid in contact with the cathode by vigorous stirring, however, good deposits may be obtained.—Mining Reporter.

RESPIRATION OF THE OLIVE.

FROM a series of observations made by M. C. Gerber on the value of the respiratory quotient CO_2/O in the formation of oil in the olive, it appears that the ripening of the olive may be divided into three periods. During the first period the fruit contains mannite which has been transferred from the leaves, and the respiratory quotient is less than unity, about 0.92. During the second period, in which the color of the olive changes from green to violet, the mannite is partially oxidized, and the value of the quotient rises to 1.40. It is during this period that the greatest production of oil takes place. During the third period, in which the color of the fruit changes from violet to black, a further production of oil takes place at the expense of the remaining mannite and other carbohydrates; and this is accompanied by a gradual decrease in the respiratory quotient, until it again becomes less than unity.—Morot's Journ. de Bot., 15, 1901.



THE GREAT CAISSON EMPLOYED IN BUILDING THE DRYDOCK AT KIEL.

THE GREAT CAISSON EMPLOYED IN BUILDING THE DRYDOCK AT KIEL.

THE CAISSON AT THE KIEL DRYDOCK.

AT a cost of about one million marks ($250,000), a huge caisson has been built to aid the construction of the new drydock at Kiel, says Illustrirte Zeitung. Since the installation of this new caisson submarine work has been performed in the construction of the new drydock with a rapidity that leaves little to be desired.

The accompanying illustration pictures vividly both the scope of the work and the manner in which it is carried out. The submarine portion of the picture shows that part of the dock which rests on the bottom of the sea and upon which the workmen are busily engaged in distributing a second layer of cement. The box-like caisson is so arranged that its longitudinal axis lies across the bed of the dock. The caisson is some 42 meters in length (134¾ feet), and covers an area of 600 square meters (6,458 square feet). When the cement has been distributed over this surface, the caisson is raised and shifted along through a distance equal to its own width. Thereupon a new layer of cement is formed. The gaps between the sections of each layer are filled when the superposed layer is formed.

The caisson is 5 meters (16.4 feet in height), and is divided by a horizontal sheet metal partition. Thus two compartments are formed, an upper compartment and an excavating-lock. The entire length of the caisson is traversed by a ballast cylinder which serves the purpose of sinking the caisson. Such a ballast cylinder is necessary for the reason that the weight of the ironwork is not in itself sufficient to sink this huge structure or to hold it rigidly in place on the bottom of the water.

Into the excavating-lock compressed air is forced through air-locks for the purpose of supplying the workmen with sufficient air to enable them to carry on their work. Along the ceiling of the excavating-lock tracks are laid, upon which the car carrying the cement runs, so that material may be distributed along the entire length of the caisson and deposited at any place. From the excavating-lock seven shafts lead upwardly, two of which inclose passenger elevators, one of which is used for the purpose of supplying cement, and four of which are used for the purpose of supplying and removing material. These shafts terminate in air-locks at their upper ends. All the shafts extend to two vessels of special construction which form a kind of catamaran bound together by an iron-framed structure. From this iron-framed structure the caisson is suspended by twenty suspender rods, ten on each side of the caisson. Upon the vessels machinery of various kinds is carried, which serves the purpose of driving the passenger elevators, supplying material to the workmen, excavating rock and removing dirt.

LAMONT'S FEED PUMPS.

WE illustrate herewith feed circulating and air pumps as manufactured by Messrs. Lamont & Company, Hawkhead, Paisley. Fig. 1 shows the feeds as arranged in the T. S. Y. "Margarita," of 5,000 indicated horse power. The chief feature of these pumps is that the steam cylinder has double ports at each end, which allow for a definite amount of compression, and the piston is thus prevented from striking the ends of the cylinder when the pump draws air. At the same time the arrangement is such that the piston can complete its full stroke when either water or air is being pumped. The exhaust from the main feed pump has a two-way valve, so that, in general work, the exhaust steam is directed by means of it into the suction of the pump. When working under these conditions all the heat that is not used in doing useful work or lost in friction or by radiation is returned to the boiler through the pump suction, which thus acts to a certain extent as a feed heater. The float tank has a spiral spring substituted in place of the customary back balance-weight. This spring is compressed to give the upward force equivalent to that of the back-balance weight, but as the float rises this force, owing to the release of the spring, decreases in greater proportion than that of the balance-weight, so that, on the reversal of motion, the action of the spring at the top position is tantamount to adding more weight to the float. A similar but reverse action takes place at the lower position of the float.

Fig. 2 shows an arrangement of independent air, circulating, and bilge pumps which are driven direct from a single steam cylinder above them. The air pump is placed in the center, one circulating pump at each side and the bilge pump behind, the pump-rods being connected by a crosshead.

Fig. 3 shows an arrangement of feed pumps, float tank, and independent air, circulating, and bilge pumps, in which the exhaust of the feed pump is used to drive the air, circulating, and bilge pumps. The exhaust from the cylinder of these pumps is returned to the suction of the feed pump. This makes these auxiliary engines work in a way similar to a compound engine, and the surplus heat is returned to the boiler. The steam distribution is indicated by the lettering on Fig. 3. *A* is the exhaust from the air and circulating pumps, *B* the exhaust from the feed pump, *C* the circulating discharge to the condenser, *D* the circulating suction from the sea, *E* the air pump suction from the condenser, *F* the discharge from the hot-well to the float tank, *G* the main feed pump discharge to the boiler, *H* the valve admitting steam to the pumps, *I* the connection for steam from the boilers to the regulating valves, and *K* the auxiliary feed-pump discharge to the boiler.

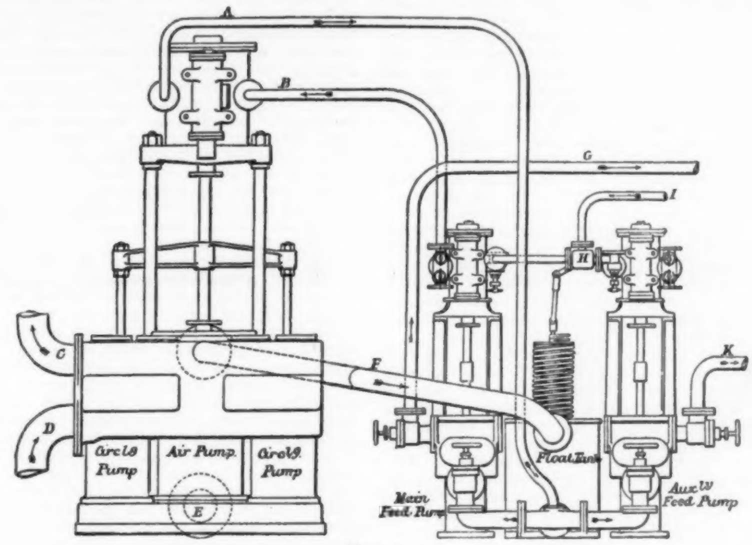


FIG. 3.

By means of this arrangement of combined independent air and circulating and bilge pumps, a vacuum can be maintained in the condenser when the main engines are starting or stopping; and the main condenser being always kept drained, when the main engines are stopped, there is no loss of water from overflow at the air pump. This system of entirely independent auxiliary pumps has been fitted on several fishing boats running in connection with other vessels where there are no independent auxiliaries. The consumption of coal is much the same with both arrangements, i. e., entirely independent auxiliary pumps or with all the auxiliaries worked from the main engines; but it is found that there is a great improvement in the condition of the boiler with the independent pumps due to the introduction of less air and make-up water. The combined air and circulating pump has also been used successfully on several dredgers and yachts of small power, but in higher-powered vessels the air pump is made independent of the circulating one. This independent air pump has been fitted to the auxiliary condensers of H. M. SS. "Sutlej," "Cressy," and "Good Hope."—Engineering.

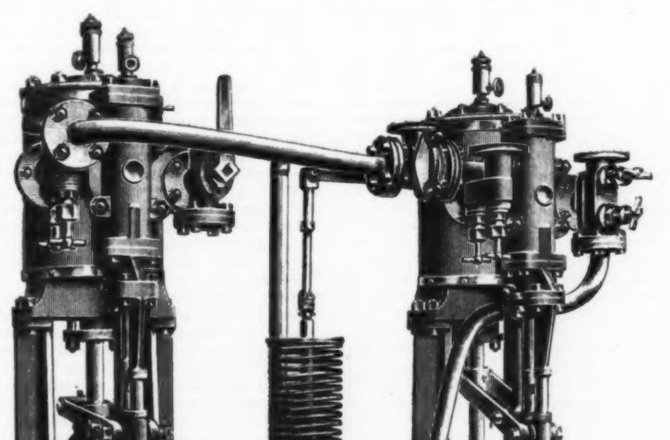


FIG. 1.

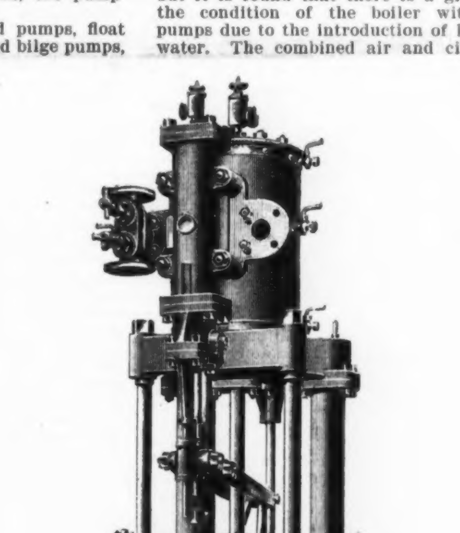


FIG. 2.

LAMONT'S SYSTEM OF PUMPS IN THE TWIN-SCREW YACHT "MARGARITA."

[Continued from SUPPLEMENT, No. 1347, page 21593.]

THE BRITISH ASSOCIATION AT GLASGOW.*

INTERCROSSING AND INTERBREEDING AS CAUSES OF VARIATION.

THE belief was once common among naturalists that variability was wholly due to crossing, and at the present day naturalists and breeders alike agree that intercrossing is a potent cause of variability, and are unanimous in regarding interbreeding as an equally potent means of checking variability. The opinion is also general that intercrossing has a swamping influence; that having brought forth new forms it forthwith proceeds to destroy them. Darwin, when discussing reversion, points out that intercrossing often speedily leads to almost complete reversion to a long-lost ancestor, i. e., to the loss of recently acquired and the reappearance of long lost characters ("Animals and Plants," vol. i. p. 22). When, however, he comes to deal with variability, he states that "crossing, like any other change in the conditions of life, seems to be an element, probably a potent one, in causing variability" (ibid., vol. ii. p. 254), the offspring of the first generation being generally uniform, but those subsequently produced displaying an almost infinite diversity of character. As to the influence of inbreeding, he says, "close interbreeding, if not carried to an injurious extreme, far from causing variability, tends to fix the character of each breed" (ibid., vol. ii., p. 251).

These statements may be quoted in support of the very common belief that intercrossing is both a potent cause of variation and of reversion; that it produces new varieties one moment and swamps them the next. Whether intercrossing may be regarded as the immediate cause of variation or of reversion (it can hardly be both) depends on what is implied by variation. Obviously variation may be either progressive or retrogressive, i. e., the offspring may differ from their parents in having quite new characters or in presenting ancestral characters or in being characterized by traits neither new nor old, due to new combinations of characters already recognized as belonging to the variety or species. When intercrossing results in the restoration of old characters, we have reversion or retrogressive variation; when to new combinations of already existing characters like new combinations in a kaleidoscope, we have new variations of a non-progressive kind, almost always characterized by more or less reversion: when, however, intercrossing results in the characters of one variety being engrafted on another, or to the appearance of characters quite new to the species, we have progressive variation. Judging from the results I have obtained, intercrossing of two distinct varieties results, as a rule, in the loss of the more striking characters of both parents, i. e., in more or less marked reversion, the extent of the loss generally depending on the difference between the forms crossed. For example, if an owl pigeon is crossed with a pigeon known among fanciers as an archangel, nondescript birds are obtained, which may at once, with a white fantail, give birds almost identical with a blue-rock—the common ancestor of all our breeds of pigeons. Intercrossing, on the other hand, rarely leads to the blending in one individual of the unaltered characters of two or more varieties, and it never results in the appearance of characters absolutely new to the species. In a word, the immediate result of intercrossing distinct varieties is, as a rule, more or less marked reversion. But though intercrossing usually results in retrogressive variation, it is *indirectly* an extremely potent cause of progressive variation. This is due to the fact (better realized by botanists than zoologists) that cross-bred offspring (first crosses) are (unless the parents have been enfeebled by interbreeding) endowed with an unusual amount of vigor, i. e., intercrossing is of supreme importance, not only because it leads to the co-mingling of germ-plasms having different tendencies, but also and perhaps chiefly because of its rejuvenating influence. The importance of this rejuvenation is usually at once evident if intercrossing is immediately followed by interbreeding. The interbreeding of closely related forms generally reduces the vigor, and, as Darwin points out, "far from causing variability, tends to fix the character of each breed" ("Animals and Plants," vol. ii, p. 251); but the intercrossing of first crosses (or of highly vigorous individuals closely related in either the direct or the collateral line) without appreciably weakening the constitution, often results in offspring displaying, to use Darwin's words, "an almost infinite diversity of character" (ibid., vol. ii, p. 256). The epidemics of variation, so often the outcome of interbreeding first or at least vigorous recently produced crosses, are apparently partly due to the union of individuals having a similar tendency checking reversion, and partly to the vigor acquired by recent intercrossing. This much may be inferred from the fact that when interbreeding is persisted in the variability dwindles as the vigor ebbs.

Breeders agree with Darwin that first crosses are generally uniform, and that the subsequent offspring usually vary immensely; yet neither breeders nor naturalists seem to have clearly realized that interbreeding at the right moment is the *direct* cause of variation, while intercrossing is, except in very rare cases, at the most an *indirect* cause of variation.

It may be here said that it is impossible to overestimate the importance of vigor in studying variation. Without vigor no race or breed can maintain its position; without renewed vigor it is hardly likely to develop new characters. The new vigor, as already explained, may be obtained by intercrossing; but it may also be acquired, especially in plants, by a change of surroundings accompanied by a plentiful supply of suitable food.

With rigid selection the gradual loss of vigor may escape notice, but when selection is suspended, rapid deterioration (from the fancier's standpoint) is the inevitable result. If, e. g., a number of pigeons, good specimens of a distinct breed, are isolated and left unmolested for a few years, they rapidly degenerate, i. e., they lose their show points (be they peaks, frills, ruffs, or metallic tints) and reassume the more fixed ancestral characters. If, however, the less characteristic birds are eliminated, and high-class birds are from time to time introduced from another loft, the vigor and the distinctive traits are indefinitely preserved.

If the age and condition of the soma and the state of ripeness of the germ-cells are potent factors, and especially if vigor counts for much, the difficulties of breeders become intelligible, and the unlikeliness of intercrossing being a direct cause of variation all the more evident. The most that can be expected from intercrossing is the engrafting on one breed the characters of another. Even this rarely happens, and is only possible when the two breeds are somewhat allied. It is impossible, e. g., to unite in one individual all the points of a fantail and a pouter, or of a fantail and a jacobin; but given healthy, vigorous birds, the points of an owl may be engrafted on a barb. Or to take another example, the black ears, feet, etc., of a Himalaya rabbit may be combined with the characteristic form, long hair and habits of an Angora. It may be impossible to predict what will happen when intercrossing is resorted to, but if pure-bred members of a distinct variety are experimented with—and it is useless working with either plants or animals of unknown origin—characters not already present in one of the varieties need not be looked for.

But while interbreeding at the right moment may be a cause of progressive variation, at other times it leads to what is perhaps best described as degeneration. When, e. g., very young members of the same brood or litter, or unhealthy, closely related individuals, or quite mature and apparently vigorous but for several generations closely related animals are interbred, the offspring frequently differ from their parents. They are often delicate and highly sensitive, and unable to survive unless provided with highly nutritious food; and though they mature numerous germ-cells they rear but few offspring, and, what is still more striking, they are sometimes either white or all but devoid of pigment. Offspring thus characterized, especially when white or nearly white in color, e. g., nearly white pheasants, partridges and woodcock, white specimens of the brown hare, white squirrels, etc., are sometimes regarded as distinct varieties, but when the departure from the normal color, etc., is the result of close inbreeding it is best regarded as degeneration.

In the spring of 1900 I crossed a quarter-wild gray doe rabbit with a closely inbred black-and-white buck. The young obtained varied considerably in color: to one of her offspring colored like the sire, the gray doe produced a second litter, all but one decidedly lighter in color than the sire. Two of the darker members of this litter produced almost white young, and to one of them the original gray doe has recently produced a light-colored litter consisting of two pure white specimens, two with only a narrow dorsal band, two fawn-colored and one black. Close interbreeding with goats and pigeons yields similar results. Birds on small remote Pacific islands are sometimes marked with irregularly disposed white patches. These pie-bald birds, like light-colored pheasants, cream colored partridges and dun-colored rooks, may also be the victims of close inbreeding.

THE SWAMPING EFFECTS OF INTERCROSSING.

The question "Are new varieties liable to be swamped by intercrossing?" is perhaps the most important now pressing for an answer from biologists. What would happen, for example, if specimens of all the different breeds of cattle were set free and left unmolested on a large area? Would they some centuries hence be represented by several breeds or by one? Many would answer this question by saying that unless some of them in course of time were isolated by mountains, deserts, or other physical barriers, they would eventually through intercrossing give rise to a single breed. To this question Darwin would, I think, have given a somewhat different answer, for, while admitting "that isolation is of considerable importance in the production of new species," he was, on the whole, "inclined to believe that largeness of area is of more importance" ("Origin of Species," p. 104). Unfortunately Darwin nowhere indicates how he supposed new varieties escape being swamped by intercrossing. His silence on this important point is difficult to explain, for during his lifetime the influence of intercrossing in checking progress except in one direction was often enough insisted on. Huxley tells us that in his earliest criticisms of the "Origin" "he ventured to point out that its logical foundation was insecure so long as experiments in selective breeding had not produced varieties which were more or less infertile" ("Life of Professor Huxley," p. 170). Later Moritz Wagner and others pointed out the important part physical isolation had played in the origin of species; and later still Romanes endeavored to show how the blighting influence of free intercrossing might be overcome by physiological selection, Romanes, like Huxley, believing several varieties might be evolved in the same area if more or less mutually infertile. Evidence of the importance of physical isolation is plentiful enough; but neither has experimental nor selective breeding proved that physiological isolation has been instrumental in arresting the swamping effects of intercrossing. Hence, according to Huxley and others, the foundation of Darwin's doctrine of natural selection must still be regarded as insecure. Is intersterility the only possible means by which new varieties can be saved from premature extinction, from being destroyed before they have a chance of proving their fitness to survive? In other words, are barriers as essential among wild as among domestic animals? It does not seem to have occurred to the biologists who so fully realized the need of isolation that the old varieties instead of swamping might be swamped by the new, and that several varieties might sometimes be sufficiently exclusive to flourish and eventually give rise to a like number of species in the same area. If on an island two new varieties of sheep appeared sufficiently vigorous, or as we say sufficiently prepotent, to swamp all the other varieties—as the ill-favored lean kine did eat up the fat ones—and yet so exclusive that their cross-bred offspring invariably belonged to the one new variety or the other, for their preservation fences and other barriers would be superfluous.

Is there any evidence that by prepotency the swamping of new varieties is sometimes checked, and that by exclusive inheritance two or more varieties, though mutually fertile, may persist in the same area, occasionally intercrossing with each other, but neither giving up nor taking from each other any of their distinctive characters? I have in my possession a skewbald Iceland pony that produces richly striped hybrids to a zebra, but skewbald offspring the image of herself in make, color, and temperament to whole-colored bay Arab and Shetland ponies. This pony instead of being swamped invariably swamps older breeds. A number of prepotent skewbald ponies, wherever placed, would (especially with the help of preferential mating) in all probability soon give rise to a distinct race such as once existed in the East. What is true of the Equidæ is equally true of other groups. Black hornless Galloway bulls are often so prepotent that their offspring with long-horned brightly-colored Highland heifers readily pass for pure-bred Galloways. The wolf is so prepotent over the dog, as the wild rabbit, rat, and mouse are prepotent over their tame relatives. As an instance of prepotency in rabbits, I may give the results of an interbreeding experiment with a gray doe, the granddaughter of a wild rabbit, and an inbred buck richly spotted like a Dalmatian hound. Of six young in the first litter three were like the sire. To one of her sons, the gray doe next produced eight young, all richly spotted, and subsequently to one of her spotted grandsons she produced two spotted, two white, and two gray offspring. Similar results are obtained with plants; hybrid orchids, e. g., sometimes reproduce all the characters of one of the parents.

It need hardly be insisted on that if new varieties, well adapted for their environment, are not only sufficiently prepotent to escape being swamped by other varieties, but are also, like the spotted rabbit, able to hand on the prepotency almost unimpaired to a majority of their descendants, progressive development along a definite line will be possible. But of even more importance than prepotency is what for want of a better name may be known as exclusive inheritance. Recently a vigorous mature Indian blue-rock pigeon mated with an inbred and equally mature fantail, hatched and reared two birds, one exactly like a blue-rock, but with fourteen instead of twelve tail feathers; the other characterized by all the points of a high-class fantail, the tail feathers being thirty in number—two fewer than in the fantail parent but eighteen more than in the blue-rock parent. In this case the blue-rock was the exclusive bird, the fantail having previously produced birds with only sixteen feathers in the tail when mated with an ordinary dovecot pigeon. A still more striking example of exclusive inheritance we have in the crow family. The carrion crow and the hooded crow are so unlike in color that they were long regarded as two distinct species; now they are said to be two varieties of the same species. The carrion crow is black all over, but in the hooded crow the breast and back are gray. These two crows cross freely (but for this they would probably still rank as distinct species); but in the crossbred young there is never any blending—they are either black or gray, usually both varieties occurring in the same nest. Similar exclusiveness occurs among mammals. When distinct varieties of cats are crossed, some of the young usually resemble one breed, some the other, and the distinctions may persist for several generations. A white crossed with a tabby-colored Persian cat produced a pair of white and a pair of tabby-colored young; the two white cats when interbred also produced two white and two tabby-colored individuals. I find cats are far more exclusive than rabbits; perhaps it is partly for this reason we have so many species and varieties of wild cats, so few species and varieties of wild rabbits. Another very striking instance of exclusiveness we have in the Ancon or "Otter" sheep common in New England at the end of the eighteenth century. This breed, which was characterized by short crooked legs and a long back like a turnspit dog, descended from a ram-lamb born in Massachusetts in 1791. The offspring of this "sport" were never intermediate in their characters; they were either like the original Ancon ram or like the breeds, some thirteen in number, with which he was mated. Frequently in the case of twins one was otter-like, the other an ordinary lamb. More remarkable still, the Ancon-like crosses, generation after generation, were as exclusive as their crooked-legged ancestor.

Another familiar example of exclusiveness we have in the peppered moth, a dark variety of which in a few years swamped the older light variety throughout a considerable part of England, and is now extending its range on the continent. It thus appears that when a new variety is sufficiently prepotent, instead of being swamped it may actually swamp the old-established variety; and that when two or more varieties are sufficiently exclusive they may flourish side by side, and eventually give rise to two or more distinct species.

Prepotency may hence be said to supplant and complete the work of the environment. The environment seems to be mainly concerned in eliminating the unfit; whether any of the survivors persist depends not so much on their surroundings as on whether they are sufficiently prepotent and exclusive to escape being swamped by intercrossing. This way of accounting for progress in one or more directions may prove as inadequate as the one suggested by isolationists, but it has the merit of being more easily tested by experiment. It not only gets rid of the swamping bugbear, but makes it matter of indifference whether (to quote from the President's address at the last Oxford meeting of the Association) "the advantageously varied bridegroom at the one end of the wood meets the bride who, by a happy contingency, had been advantageously varied in the same direction, and at the same time at the other end of the wood." Further, as a highly prepotent vigorous variety can well afford to maintain a number of budding organs, it helps us to understand how luminous, electric and certain other structures were nursed up to the point when they began to count in the struggle for existence.

DOUBTFUL CAUSES OF VARIATION.

Having indicated how maturity of the soma and of the germ-cells, and how bodily welfare and interbreeding may act as causes of variation, and also how swamping of the new variations may be checked, I shall now refer to certain supposed causes of variation.

* Opening Address by Prof. J. Cossar Ewart, M.D., F.R.S., President of Section D.

MATERNAL IMPRESSIONS.

I may begin with the widespread belief that the offspring are capable of being influenced in form, color, and temperament by maternal impressions—the belief we associate with the skillful shepherd who peeled wands and stuck them up before the fulsome ewes. Muller ("Elements of Physiology," vol. ii. p. 1405) more than half a century ago, conclusively argued against the belief in maternal impressions, but the belief still prevails. I know of two able naturalists who subscribe to the maternal impression doctrine, and it is firmly held by many breeders and by not a few physicians. A writer in a recent number of a quarterly (Bibby's Quarterly, Autumn Number, 1900, p. 163), which circulates widely among farmers and stock-breeders, boldly asserts that the existence of impressions which affect progeny (more especially in color) is a settled fact. This writer supports his case by referring to a highly successful breeder of polled Angus cattle, who considered it necessary to surround his herd "with a tight black fence in order to keep the females from dropping red calves because they saw the red herds of his neighbors." Reference is also made by this writer to the belief, common in certain parts of England, that whitewashed byres, regardless of the color of the parents, produce light-colored calves; that the color of foals is often more influenced by the stable companion of the dam than by her own color or that of the sire; and that even the color of birds varies with the immediate surroundings, fowls, e. g., however carefully penned, hatching birds resembling in color the hens they habitually see in a neighboring run. If maternal impressions thus influence the offspring they must be one of the most effective causes of variation. During the last six years I have bred many hundreds of animals, but the nearest approach to an instance of maternal impressions was a dark pup with a white ring half round the neck, which suggested the white metal collar sometimes worn by his sire. But similar rings round the legs and tail rather discredited the view that the white neck-ring was in any way related to the sire's nickel-plated collar. Telegony was sometimes said to be due to maternal impressions. It was doubtless for this reason that I was urged some years ago to carefully prevent the mares used in my experiments from seeing too much of the zebras. But though numerous foals have been bred from mares stabled with zebras or grazing with richly striped zebra hybrids, not a particle of evidence have I found in support of the maternal impression doctrine. The foals have neither stripes nor upright manes, and do not even attempt to mock the weird barking call of the zebra. Sheep and cattle, goats, rabbits and guinea-pigs, fowls and pigeons, have simply confirmed the results obtained with horses. This being the case, grooms may very well omit following the practice (considered so essential in Spain during the Middle Ages, and still often religiously observed in England and America) of setting "before the mares . . . the most goodly beasts" by way of hinting to them the kind of foals they are expected to produce.

THE NEEDS OF THE ORGANISM AS A CAUSE OF VARIATION.

No recent biologists are perhaps prepared to believe like Lamarck that the wings of birds were developed by their remote ancestors making efforts to fly; that by stretching its toes the otter acquired webbed feet; nor are they prepared to find in our new mammal, the Ocapi, evidence in support of Lamarck's contention that to meet new needs the giraffe by much stretching gradually lengthened his neck. Yet it is difficult sometimes to see any real difference between the beliefs of the new Lamarckians and the old. It is maintained, for example, "that when a certain functional activity produces a certain change in one generation it will produce it more easily the next," that, e. g., flounders and their allies by constant efforts generation after generation have dragged the left eye to the right side, while by similar efforts in the turbot and certain other flat fishes the right eye has been shifted to the left side. It is not alleged by Neo-Lamarckians that globe fishes resulted from round fishes blowing themselves out, or that flounders resulted from round fishes generation after generation making efforts to flatten themselves. If by general variation and selection flounders were evolved out of round fishes, is it not straining at a gnat and swallowing a camel to refuse to admit that by the same factors the left eye of the flounder has been transferred from the left to the right side of the head? In the flat fishes it is not difficult to imagine how by variation and selection the eyes originally acquired the power of responding to certain external stimuli.

THE DIRECT ACTION OF THE ENVIRONMENT AND USE-INHERITANCE AS CAUSES OF VARIATION.

Of the doctrine of the transmission of acquired characters, still so often the subject of discussion, I need say little more than that I have failed to discover any evidence in its favor. Writing in 1876, Darwin says: "In my opinion the greatest error which I have committed has been not allowing sufficient weight to the direct action of the environment, i. e., food, climate, etc., independently of natural selection" ("Life and Letters": Letter to Moritz Wagner). Darwin not only in his later years reverted to the teaching of Buffon, but in as far as he continued to believe in the "inherited effects of use and disuse" he adopted the views of Erasmus Darwin and Lamarck. While admitting that the direct action of the environment on the soma and use-inheritance are indirect—it may be potent—causes of variation, I do not believe there is any trustworthy evidence in support of the view that definite somatic variations are ever transmitted.

TELEGONY AS A CAUSE OF VARIATION.

The belief in telegony is less deserving of consideration than the doctrine of the transmission of acquired characters. Nevertheless I perhaps ought to refer to it at greater length, not so much because of its scientific importance, but because it interests all sorts and conditions of men in many different parts of the world. Telegony ("infection of the germ" of older writers) means that not only the immediate parents but also the previous mates (if any) contribute to the characters of the offspring; that, e. g., a mare which had produced foals to, say, "Ladas" and "Persimmon" might thereafter give birth to a foal by "Flying Fox," to which "Ladas" and "Persimmon," as well as the actual sire, contributed some of their characteristics. Many even think a sire may transmit definite structural characters from one mate to another. If there is such a thing as telegony, if it is possible to blend without the risks of intercrossing the characteristics of several individuals or varieties, progressive development would be greatly accelerated. Though the doctrine of "infection" has probably long formed part of the breeder's creed, it received but little attention from men of science until in 1820 Lord Morton communicated a case of infection to the Royal Society, which in due time was published in the Philosophical Transactions. In this, the most credible and best authenticated of all the cases of telegony on record, a chestnut mare, after rearing a quagga hybrid, produced to a black Arabian horse three foals of a peculiar bay color, one of them (a filly) showing more stripes than the quagga hybrid, and, according to the stud groom in charge of "the colts," characterized by a mane "which from the first was short, stiff, and upright" (Phil. Trans., 1820, p. 21). Darwin, after fully considering Lord Morton's case, came to the conclusion that the chestnut mare had been infected, and this case along with others led him to believe that the first male influenced "the progeny subsequently borne by the mother to other males" ("Animals and Plants," vol. ii, pp. 435, 436). If the upright zebra-like mane in one of the pure-bred colts and the markings on all three were the result of the chestnut mare having been first mated with a quagga, there is undoubtedly such a thing as telegony, and the presumption is that other mares first mated with a quagga or zebra and then with a black Arabian would give birth to striped offspring with a stiff if not quite upright mane. The evidence that from the first the mane of the filly was short, stiff, and upright is most unsatisfactory. It consists of an allegation by a stud groom. That the mane was upright, as in the quagga and zebra, is *a priori* improbable (1) because the mane of the quagga hybrid instead of being short and stiff was long and lank enough to arch to one side of the neck; (2) because the mane of zebra hybrids throughout the greater part of the year is so long that it falls to one or it may be both sides of the neck; and (3) because in the Equidæ an upright mane is always accompanied by a tail deficient of hairs at the root—in the filly the tail is as perfect as that of her Arab sire. We have still stronger evidence that the allegation of the groom was unfounded from drawings (of the chestnut mare, her three "colts," the black Arab, the quagga, and the quagga hybrid) by Agasse, a very trustworthy animal painter of the early part of last century. In the drawing of the filly the mane is represented as lying to one side, as in Arabs and other well-bred horses. The pictures (now in the Museum of the Royal College of Surgeons, London) were made because the subsequent foals were believed to prove the truth of the "infection" doctrine. Had the mane of the filly been erect it would hardly have escaped the keen eyes of the artist. But had Agasse by any chance missed this all-important detail, Lord Morton or some of those interested would doubtless have called his attention to the matter. If the mane of an Arab is completely removed early in the spring it is stiff and upright in the autumn, but hanging to one side close to the neck in the following summer. When the whole circumstances are taken into consideration, there seems to me no escape from the conclusion that the mane of the filly was upright when seen by Lord Morton in August, 1820, and lying to one side when painted by Agasse the following summer, because it had been regularly cropped or at least hogged some months before Lord Morton's visit. But whatever be the explanation of the want of agreement between the mane as seen by Lord Morton and as depicted by Agasse, it will, I think, be admitted that the evidence afforded by the mane of the filly is hardly sufficient to establish the truth of the doctrine of telegony. Of still less value is the evidence afforded by the make, coat, color and markings which were apparently too indistinct to deserve the name of stripes. The coats were decidedly Arab-like, of a bay color marked more or less "in a darker tint." Judging from Agasse's drawings they closely resemble Arab-Indian crosses; they are, in fact, in make very like the Arab-Kattiawar horse already referred to. I have seen a bay Highland cob with as many stripes as Lord Morton's colts, and pure-bred Arabs of a dun color with stripes on the neck and far more distinct leg bars than those depicted by Agasse. I believe the colts owed their stripes and color not to "infection" of their dam by her previous mate the quagga, but to reversion. It is quite possible the black Arabian horse was of mixed origin; that the chestnut mare was crossbred is admitted. As in the west of Ireland the offspring of black and chestnut ponies are sometimes of a decidedly dun color, it is not surprising that the black Arab and the half-bred chestnut had bay offspring. Neither are the stripes surprising. I recently ascertained that the chestnut mare was presented to Lord Morton (while serving with his regiment in India) by one of his officers—Mr. Boswell, of Deeside, Aberdeenshire—and that she was most likely a cross between an Arab and a country-bred pony. In Kattiawar the ponies when pure-bred are of a rufous gray color and more or less richly striped. If in the chestnut mare there was any Kattiawar or even any native pony blood its offspring to a black sire might have been expected to be of a dun color and striped. In a word, there is no reason for assuming that the foals would have been less striped if the chestnut mare had been mated with the black Arab first and the quagga afterward.

By way of testing the truth of the "infection" doctrine I started, in 1895, a number of experiments, and especially arranged to repeat as accurately as possible, what is commonly called Lord Morton's experiment. Since then twelve mares after producing sixteen zebra hybrids, a mule, and a hinny, have had an opportunity of supporting the telegony hypothesis by giving birth to twenty-two pure-bred foals.

During the same period Baron de Parana of Brazil has bred at least six zebra hybrids, and some of the dams of these hybrids subsequently produced ordinary foals. Further, Baron de Parana has for a number of years been engaged in crossing cattle and in watching the results obtained in several mule-breeding establishments, where from 400 to 1,000 brood mares are kept. As in these establishments the mares breed mules and horses alternately—two or three mules and then a horse foal—there has been carried on for some years, under the observation of Baron de Parana, a telegony experiment on a gigantic scale.

The single hybrid bred by Lord Morton had extremely few stripes, and only in a remote way suggested a member of the zebra family. All my hybrids, like those bred in Brazil, have more stripes than their zebra sire, and in some of them the bands are nearly as conspicuous as in some of the zebras, thus proving that both the mares (which varied in color and breed) and the two zebra stallions used were well adapted for the experiment. The results of my experiments, not only with the Equidæ but also with other domestic quadrupeds and birds, all point to the conclusion that there is no such thing as telegony, and the same conclusion has been independently arrived at by Baron de Parana in Brazil. Believers in telegony—they are numerous in America, India, and Australasia, as well as in England—almost always say of the many experiments recently made with a view to giving "infection" a chance of showing itself that they have only yielded negative results, and they generally add, it is impossible to prove a negative. After carefully considering all the more striking so-called cases of "infection," I have no hesitation in saying that there is no satisfactory evidence that there has ever been, either in the human family or among domestic animals, a single instance of infection.

I have in a hurried and imperfect manner indicated that we are not likely to find either in maternal impressions, the direct action of the environment, use-inheritance, or telegony a true cause of variation. I have endeavored to point out that, instead of simply stating that variation is due to the constant recurrence of slight inequalities of nutrition of the germ-cells, we may with some confidence assert that differences in the age, vigor, and health of the parents and differences in the ripeness of the germ-cells are potent causes of variation.

I have also endeavored to prove that intercrossing, though a *direct* cause of retrogressive variation, is only an *indirect* cause of progressive variation, while interbreeding (in-and-inbreeding) at the right moment is a cause of progressive variation.

Further, I have discussed at some length the swamping effects of intercrossing, chiefly with the object of showing (1) that progress in a single direction is probably often due to new varieties swamping old, it may be long established, varieties; and (2) that several varieties may be sufficiently exclusive to flourish side by side in the same area, and eventually (partly owing to their aloofness, i. e., to differential mating) give rise to several new species.

I have only now to add that I was mainly led to select "The Experimental Study of Variation" as the subject of my address that I might indirectly indicate that the time had come when a well-equipped institute should be provided for biological and other experiments.

ROMAN OCULIST SEALS.

SOME two years have elapsed since my announcement of the discovery of a Roman oculist seal, but at the February meeting of the French Academy of Inscriptions a description of two new ones was given, one of which is probably the finest specimen of these interesting relics found for many years, says The Lancet. They were unearthed during the excavation of a Roman villa near the ancient city of Nasium in the Department of the Meuse. The best-preserved seal bears a four-fold inscription and belonged to an oculist named Q. Valerius Flaviarius, a personage hitherto unknown. The collyria given by, and the contents of the four texts, omitting the name which is at the commencement of each one, are as follows: Euodes ad veteres cicatrices ex t(ilia); Dialepedos ad veteres cicatrices ex ti(lia); Diasmyrnes post impetum pituitae ex ovo*; Diasmisus ad aspritudines. The first collyrium, Euodes, means simply perfume, but of what it consisted we do not know. There are other collyria of the ingredients of which we are ignorant, such as Anodynum and Diatessarium— *i. e.*, the four ingredients. The cicatrices were affections of the transparent cornea and the pupils and are especially referred to by Pliny, Celsus, and Galen. The second, Dialepedos, used for the same remedial purpose, is protoxide of copper and is frequently stated upon the seals to have been applied for aspritudo, or trachoma. These two collyria, however, Flaviarius tells us, contained another ingredient the first letters of which were "Ti," and it is this which will constitute the special value of this signet, for the word is new. M. Thedenat argues that it stands for "tilia," the lime tree. These oculist seals, after denoting the chief medicament, generally give the vehicle in which it was applied, such as "e lacte muliebri," or, as upon this seal, "ex ovo," and there is no reason to doubt that "ti" indicates a decoction of lime-leaves or limes. For of the tilia, or lime, Pliny expressly tells us that decoctions of its leaves were used for the same medical purposes as those of the wild olive, "for inflammation of the eyes," and of the latter he singularly says: "Miscentur oculorum medicamentis et decoctum foliorum et succus oleastri." The ex ti(lia) of the Flaviarius seal will correspond to the "miscentur oculorum medicamentis" of Pliny, and this reading of the text may be accepted. The third collyrium, Diasmyrnes, myrrh, is very common on the seals, especially as a remedy for post impetum pituitæ (lippitudinis); that is, after the mucous secretion of ophthalmia. The myrrh here is to be mixed with portions of eggs. The fourth substance, Diasmisus (probably sulphate of iron), is a remedy for the palpebral granulations, or trachoma. It was a favorite ingredient with Roman oculists and is spoken of by Marcellus, Dioscorides, Galen, and Pliny. The possessor of the second seal was one Tiberius Claudius Di———, and it also has an inscription upon the four sides, though only three of these name collyria, and not any of them inform us for what form of eye disease they were prescribed. The three given are "Stactum, de-

* A seal found in Hungary reads: "Diasmyrnes post impetum ex ovo."

lachrimatorium," that is, oil of myrrh, to produce tears; "Diasmyrnes," also myrrh; and "Crocodes anodynum," saffron with an anodyne. The fourth text speaks of a sweet, or pleasant collyrium of "T. Claudius Di——— and Solon." Who this medical Solon was is uncertain, but Galen mentions a Solon as the author of several aural remedies. It would be easy, by means of the Corpus of Oculist Seals of 1897, to trace all the maladies for which myrrh and saffron are designated in them, but as we are not certain as to which of them the owner of this seal applied them it is hardly worth doing.

CARE BESTOWED BY FISHES UPON THEIR YOUNG.

CERTAIN fish display considerable originality in the method which they employ to assure the perpetuation of their species. The majority of these animals simply abandon their fry to the water. Migratory fishes, however, always select a place favorable for their oviposition. The trout, by means of lateral motions of the tail, forms a depression in which it deposits its eggs, and the salmon acts in the same manner; then fecundation takes place, and the male and female cover the eggs with a layer of gravel, in order to prevent them from being carried away by the current. The perch secures its eggs to aquatic plants, to pieces of wood and to stones. Other species construct a genuine nest, and what is remarkable is that it is always the male that does the work. The case of the stickleback is so well known that we need not dwell upon it at any great length. The male constructs a nest of interlaced vegetable fibers and then attracts thereto a female, which, after depositing her eggs, goes away and pays no further attention to them. The male, on the contrary, remains in the vicinity of the nest until the moment of hatching, that is to say, for an entire month, during which it zealously protects its charge against other fishes.

Arius Australis, a silurid, which inhabits the rivers of Australia, likewise constructs a sort of nest. It collects together a lot of sand and pebbles at the bottom of the water and thus makes a platform for the reception of its eggs. It afterward covers the latter with pebbles, so as to prevent them from being carried away by the current, and to protect them against such animals as might be tempted to eat them.

Another sort of nidification is presented to us by the paradise fish (*Macropodium*). In this magnificent species, a native of Southern China, the male, at the moment of oviposition, forms a float of foam. To this effect, it places itself near the surface of the water and continuously absorbs and expels bubbles of air. It collects the eggs in its mouth, carries them to the float and secures them to the under surface of the latter. It afterward remains in the vicinity and occupies itself with keeping the foamy mass in repair and carrying back to it the eggs that chance to escape. After hatching, it continues to give the fry the same care that it bestowed upon the eggs. It swims in pursuit of the young that escape from the float and brings them back to the protecting fold. It does not abandon its young until the latter are strong enough to take care of themselves. Let us note, by the way, that the males of this species display considerable coquetry in order to attract the females.

Again, let us mention the *Antennarius marmoratus*, an animal which, by its form and appendages, imitates the sargassum amid which it lives, and thus succeeds in concealing itself and escaping from its enemies. According to M. Filhol, this fish constructs a genuine nest, the elements of which are furnished by the sargassum. It forms bundles of this seaweed with its fins, deposits its eggs upon them, and keeps the latter fixed by surrounding them with viscid threads, which it secretes. These floating nests, which are of the size of a cocoanut, are abandoned on the surface of the ocean. The young, after emerging from the egg, find a safe asylum therein during the first period of their existence.

A few other species of nest-building fishes have been described, but the facts are not sufficiently well established to permit of our stating them here.

If, now, we study the organic arrangements designed to protect the eggs, we shall find the same variety that we observe among the batrachians. Take, for example, the *Aspredo lævis*, a fish common in the waters of Surinam. At the moment of reproduction, the skin of the female's belly becomes soft and spongy. After oviposition she lies upon the eggs, and the latter become fixed to the entire under part of her body, from the mouth to the tail (Fig. 1).

FIG. 2.—HIPPOCAMPUS—INCUBATING POCKET OF THE MALE.

Each egg is borne by a sort of pedicle into which nourishing vessels enter (Fig. 3). This mode of development is analogous to that of the *Pipa dorsigera*, or Surinam toad.

In the female of the *Solenostoma*, the ventral fins are very wide, and become fused with the skin of the body and thus form a large pocket for the reception of the eggs, which are fixed therein by means of viscid

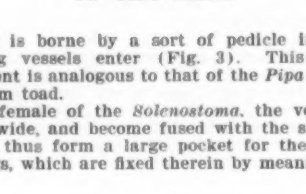


FIG. 3.—SECTION OF THE EMBRYO OF ASPREDO.

a, embryo; *b*, pedicle; *cd*, nourishing vessels.

filaments. In the Syngnathids, the pocket is formed by a cutaneous fold; in the *Hippocampus* (Fig. 2), it is open only in front and its orifice is very narrow. In these latter cases it is not the female, but the male that exhibits this curious conformation resembling that of the marsupials. It is not known how the eggs enter the pockets designed to receive them.

Like certain batrachians, *Rhinoderma Darwini*, for example, there are fishes that swallow their eggs in order the better to protect them. Examples of these may be found in the genera *Arius* and *Galeichthys* (family of the Siluridæ) and in several species of the group Cichlidæ. In the majority of these fishes, the male carries the recently laid eggs in its mouth and branchial chamber. These cavities are distended, the hyoid bone is pushed back, and we ask ourselves how the animal can take food during all this period and how the eggs can remain in place until the time of hatching without being crushed and entering the stomach.

There is another group of facts which is interesting from a very different viewpoint. The *Embiotocæ* or wrasses of the west coast of California, and the *Pœciliæ*, a sort of carp of Brazil, are viviparous. The young are developed in the ovary and even attain large dimensions therein. Thus, *Embiotoca Jacksoni*, which is 12 inches in length, produces fry that are from 3 to 4 inches in length at the time of hatching. In the viviparous eelpout (*Zoarces viviparus*), the walls of the ovary secrete a liquid containing numerous blood globules. The embryos swallow this liquid and are nourished by it. We have here, then, an arrangement analogous to that of mammals. The young are developed directly in the maternal organs; but, instead of being fed through the intermedium of a vascular system, they swallow and digest the nutritive substances furnished them by their mother. Nevertheless, in a certain number of viviparous cartilaginous fishes, there are established vascular bands between the eggs in the course of development and the uterine cavity that contains them.

Such are some of the most remarkable cases of instinct or of organic arrangement designed to facilitate the perpetuity of the species in fishes. As well known, the great majority of the animals belonging to the groups of batrachians and fishes simply lay their eggs in the water and abandon them to themselves. We may therefore ask why it has been necessary for certain of these species to improve themselves with a view to assuring a preservation of their progeniture. It would be interesting notably to know whether the number of eggs is less in the batrachians and fishes that exhibit one or the other of the arrangements described above than in those that are deprived of them. A priori, it may be affirmed that such is the case. In fact, in the upper animals and plants, in which numerous precautions are taken to assure the preservation of eggs or seeds, the number of such organs is always much smaller than in the lower species. On another hand, we have seen the most unlooked for arrangements exhibited in groups of fishes that are very remote from each other. There would be reason for inquiring whether there are not intermediate degrees and whether these so abnormal arrangements are not announced and prepared, in a manner, by simpler organs met with in other groups. These are problems that can be solved only by numerous and attentive observations.—Dr. L. Laloy, in La Nature.

RECENT DISCOVERIES IN ARMENIA.

EXPEDITIONS have recently been engaged in exploring the ruins of Armenia on behalf of the German government. The first of these was under the direction of Dr. W. Belck in 1891, and he likewise conducted a second course, in which he was assisted by Dr. C. F. Lehmann, in 1898-99. The reports of these expeditions, which are now issued, contain most important discoveries.

The history of the Armenian kingdom is an extraordinary example of the recovery of a nation, all traces of which had been entirely lost. Similar results have taken place with regard to the Hittites, the people of Mittani or Northern Mesopotamia and the pre-Hellenic inhabitants of Crete. But the present is an age of resurrections. The restoration of the history and the civilization of the pre-Aryan race of Armenia is, however, most important, as it fills up a gap which has long been open in any attempt to reconstruct the history of Western Asia.

It is evident that in the latter part of the tenth century B. C. the Assyrian kings pushed their forces into the mountains of Uratu or Ararat (as the country was then called). They invaded the regions round Van, and exacted tribute from the King Sardur. To commemorate these victories the Assyrian monarchs carved upon the rocks of Tebenek-su and other places near the head waters of the Tigris, long inscriptions. These incited the Vannic kings to have similar records, but they possessed no script of their own. Assyrian scribes were accordingly employed to cut them, and both Sardur I. and Ispurnis (the contemporary of Samsi-Rimman, King of Assyria B. C. 825-12) had such inscriptions carved. The Armenians soon adapted the Assyrian syllabary to their own tongue, and Mermas, who reigned with Ispurnis for a time and then succeeded him, placed his records on rocks all over the country, no less than seven long inscriptions of his having been copied by the German expedition.

The capital of the empire at that time was Van, known then as Dusporia (the modern Topsh), but it was also known as Khaldistun, from the national name Khaldini, the Khaldaioi of Xenophon and Herodotus. The chief royal residence was in the palace temple, the ruins of which are known as Toprak-Khalah. This site was partially explored by Mr. Hormuzd Kassam, and the British Museum possesses some shields of Rusas and Argistes, kings who ruled there about B. C. 700-660. But the German expedition has brought to light many inscriptions and some fine bronze shields and part of an altar, all now in the Museum at Berlin. There was also a fine Hittite inscription, no doubt captured by King Mermas in his wars with that race.

The remains of Armenian art are extremely interesting, as, like the writing, the style has been borrowed from the Assyrian; but the winged bulls, the lions and the curious thrones supported by lines of captives (similar to the throne of Sennacherib in the Lachish sculptures) are all somewhat conventional. It is, moreover, important to note that these conventional

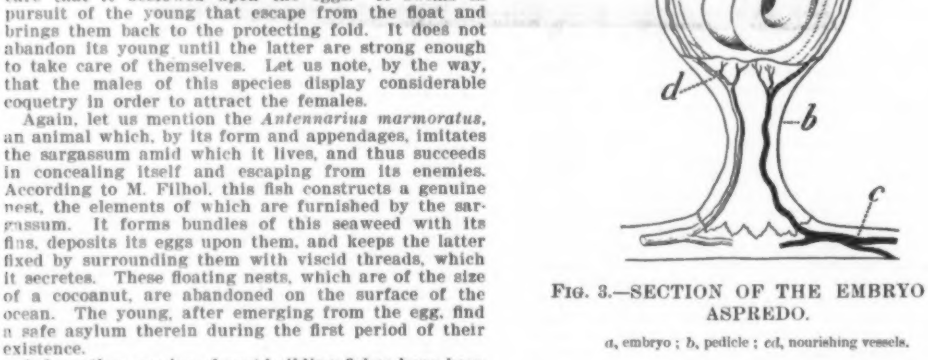


FIG. 1.—ASPREDO LÆVIS.

forms are reproduced in the Persian sculptures at Persepolis. It is impossible that Persian art could have been borrowed direct from Nineveh, and in Armenian art we have manifestly the connecting link. In the same way it was the Armenians who first taught the Persians to set up rock inscriptions. On the fortress at Van there is a tablet with a trilingual inscription of Xerxes, but it was really cut for Darius, and it was probably during the suppression of the Armenian revolt that the Persian king saw this, and formed the desire to have such an inscription. The Behistun text is certainly later. A fine copy and photographs of this were obtained by Dr. Lehmann.—The Architect and Contract Reporter.

THE DATE PALMS OF BISKRA.

BISKRA, Algeria, is noted for its date palms, and our engraving, which is reproduced from the Year Book of the Department of Agriculture, shows several excellent examples. The dates are borne in bunches which have a single stem with numerous slender twigs to which the fruit is attached. A bunch carries from ten to thirty pounds. It is very rare that all the dates on a bunch ripen at once, and in the case of choice varieties those which first ripen are frequently hand-packed and shipped immediately, in order to get the high prices paid for the earliest shipments. It is also claimed that picking the outer dates of the bunch, which usually ripen first, permits the inner fruit to ripen better. Often when most of these dates are ripe, and the remainder begin to ripen, says Prof. Walter P. Swingle, Agricultural Explorer of the Section of Seed and Plant Introduction of the United States Department of Agriculture, the whole bunch is cut off and hung up in a dry and shady place. It is necessary to remove any dates which have begun to spoil before the bunches are hung up, for if such dates are left the whole bunch will soon spoil. Usually within a few weeks all the dates ripen and the bunch is ready for shipment. The choice varieties of dates are shipped from the Sahara either in bags or more often in long wooden boxes. They are afterward repacked in smaller boxes holding from one to two pounds. The Arabs usually hang up the bunches and allow the juice to run off into jars. This juice, which they call date honey, is preserved and used, and the fruit which has become somewhat dry is then packed in boxes, or more often in skins. Dates of this class are usually packed tightly, and they keep for many years without deterioration.

THE MECHANISM OF A SUNSET.

By ARTHUR H. BELL, in Knowledge.

MOST people if they were asked to state the color of the sun would say that it was orange, and they would as confidently assert that the color of the atmosphere was blue. Recent researches and investigations, however, point to the conclusion that the real color of the sun is blue, while that of the atmosphere surrounding the earth is orange. Commonly the earth's atmosphere appears so transparent and translucent that it is hard to realize the fact that it has as much effect on the light and heat coming from the sun as if it were a roof of thick glass. But the atmosphere is very far from being as colorless as it seems to be, and the best way of discovering its true tint is, not to gaze immediately overhead, but to look away toward the horizon. By so doing the atmosphere will be seen, as it were, in bulk; for overhead there is only a small accumulation of it compared with the many miles of thickness through which the vision travels when the eye looks toward the horizon.

The atmosphere surrounding the earth, then, may be likened to a screen of an orange color, and it will readily be understood that any light passing through this screen will experience some remarkable modifications. Now, as already stated, it appears highly probable that supposing anyone could see the sun from a position outside the earth's atmosphere the light coming from this central luminary would be seen to be not white but blue. This blue is, of course, not a pure monochromatic blue, and the expression really means that it sums up the dominant note in the color scheme. What, therefore, the atmosphere may be considered to do is to stop out, or absorb, all the colors at the blue end of the spectrum, the residue filtering through to the earth as white light. When the rays of light first left the sun the blue rays were the strongest; but very soon after they entered the earth's atmosphere their progress was impeded, and of all the rays journeying from the sun they quickly became the weakest. On the other hand, the red rays, which at first were inconspicuous, had the facility of penetrating the earth's atmosphere, and were the most in evidence at the end of their long journey.

The first step, accordingly, to be taken when investigating a sunset is to realize that the white light from the sun which is commonly supposed to be composed of the seven primary colors should rather be thought of as a residue of the original radiations. A further important point is to bear in mind that all radiations of light are of different wave lengths. This fact, indeed, is at the very foundation, so to speak, of all sunsets, and it is the prime agency by which their flaming, gorgeous tints and colors are produced. It is due to this fact, for instance, that in the neighborhood of large towns, the sun nearly always appears to set as a red ball of fire. The rays of light at the red end of the spectrum are of a much longer wave length than any of their fellow rays, and so are the best qualified for penetrating the dense bank of haze which so commonly floats over all large towns and cities. In such localities, as the sun sinks to rest, the green rays are first absorbed by this bank of haze, and then the yellow, and lastly the orange and the red, the latter, more often than not, being the only ones to get through at all. A careful observation of a sunset will reveal the fact that the colors fade in the above mentioned order, and the reason they do so is that they are of different wave lengths.

In recent years the methods of observing the changes in the weather have been much improved, and since it is highly desirable that the observations should be capable of being compared with each other, the effort is made so to arrange that observations made at different places shall be conducted on a uniform plan. Now the coloring of a sunset gives such valuable information as regards the atmosphere in respect of the amount of moisture that may be floating in the air, that increased attention is being given every year to the work of observing and recording the quality of the sunset in various localities. The United States Weather Bureau, for instance, have in the principal streets of the large towns certain places where the latest weather reports and forecasts are displayed for the information of the public. In addition to this information there are also certain disks of various colors which are exposed in accordance with the color of the latest sunset; and from this fact it will be gathered that the authorities attach a good deal of importance to information regarding the color of the most recent sunset. It being clear, therefore, that sunset observations are of value, not only on the ground that they assist to a right understanding of the causes by which the sunsets are produced, but also because they are of use as aids to forecasting the weather, it becomes important that some systematic method should be devised for recording the observations, and it is satisfactory to know that a very simple way of registering sunsets has been adopted.

Supposing that anyone should be desirous of keeping a record of the color of the sunsets in his neighborhood, a record it may be said that will afford considerable pleasure, especially during the autumn days, there is a very easy way of going to work. All that needs to be done is to divide the sunsets into classes after the following manner: There are in the first place those sunsets which may be described as clear, this definition being taken to mean that there were no clouds in the sky, and few brilliant colors, the color predominating being red. Further, the term yellow is employed to describe the quality of the sunset when this color unmistakably overwhelms all others. Green is a color rarely seen in sunsets, but when it appears at all prominently it serves to define a third class of sunsets. Fourthly, there are those sunsets which are best described as cloudy, and in this variety there is commonly a dense barrier or bastion of cloud that completely absorbs all color and effectively darkens the western sky.

At many of the observatories scattered throughout the world, not only are sunsets thus relegated to certain definite classes, but, in order to give the record a scientific value, still further particulars concerning the sunset are added. Thus the position of the colors as regards their position in the sky, or as regards altitude and azimuth, as the terms are, are observed; while the time at which the colors were seen and any increase or decrease in the brilliance of the coloring would also be considered worthy of a place in the records. In all such systematic observations the time when the colors were at their brightest, and when they faded away, would be noted, and, further, in order to make the record quite complete, the time of sunset or sunrise would also be registered.

Now, the color in the sky may, as it were, be painted on the clouds, or on the hazy air, or on the open sky itself. As regards the latter the color that is most conspicuous is, of course, the blue, and in seeking for the origin of this tint it will be found that the search leads to an explanation of many of the other colors. On looking up into the sky on a cloudless, sunny day, when the swallows, perhaps, are flying so high that they appear but as tiny specks in the dome of blue, it seems almost impossible to think of the atmosphere as being otherwise than perfectly clear and translucent. It is, however, in reality charged with minute dusty particles which have always been found in myriads, whenever the atmosphere has been tested either over the open sea or at the top of high mountains. There is an ingenious instrument, indeed, by which the number of these atoms of dust in any given quantity of air may be counted, and by its aid samples of air in many different parts of the world and at different seasons of the year have been analyzed and the atoms counted. The sources from which this atmospheric dust is obtained are large. From the land, and more especially from deserts, dust is continually rising, and the dust so raised is carried by the winds to all parts. Spicules of salt, too, leap from the sea in myriads, and go to increase the stores of dust. Other sources of atmospheric dust are found in the stream of meteors which are continually plunging into the earth's atmosphere, their combustion also resulting in atmospheric dust. Volcanoes again are important distributors of dust. A cigarette smoker casts some 4,000,000,000 dusty atoms into the air at every puff; while the shaking of door mats and other similar operations constantly serve to launch a never failing stream of dusty particles into the air. These particles of dust, it will be seen, are the agents principally responsible for tinting the atmosphere blue and for filtering out the gorgeous hues of a sunset.

In respect of these atoms of dust the atmosphere may be likened to some brobdingnagian vessel; for these atoms are always falling slowly downward toward the earth like particles of chalk in a glass of water. As might therefore be expected, the lower strata of the atmosphere are most crowded and congested with these dusty loiterers, as is well illustrated when on a calm windless day these atoms settle downward in such dense crowds and multitudes as to produce a dense black fog. But far above these lower levels the dusty atoms find their way, and since they are able to float so easily in these rarefied regions it is obvious that they must be of a lighter build and of more attenuated proportions than their relations which dwell where the air is dense. Even at these great heights there are ascensional currents of air which keep the tiny particles of dust floating. Although these particles are spoken of as dust, many of them are so minute that a microscope fails to render them visible, and the only way in which they reveal their presence is by their effects. Not only, therefore, do dusty particles pervade the atmosphere in all parts, but they vary in size from those that are coarse and readily discernible to others that are below microscopic sight.

DATE PALMS LOADED WITH RIPE FRUIT, BISKRA, ALGERIA.

[Negative by Naudin, Paris.]

Dusty atoms are further to be conceived as offering considerable resistance to the passage of the rays of light which emanate from the sun. Luminous bodies, as is well known, shed rays of light of varying wave length, as the term is; and as regards human vision only those rays whose wave length is between 0.00036 and 0.00075 millimeter can be seen. As these waves of light surge through the atmosphere, not only does their wave length affect their manner of passing through the earth's atmosphere, but the different sizes of the dusty atoms against which the rays of light strike introduce other modifications. Thus, many atoms of dust are of a smaller dimension than the wave-lengths of light that rush in among them. Hence it happens that the red and orange rays which are of a large wave length pass over these obstacles with comparative ease; but the blue rays which are of a shorter wave length are stopped, and the blue light is, as it were, turned out of its course and scattered. Lord Rayleigh has suggested that it is to this selective scattering of the finer rays that the blue of the sky is due. This action has been illustrated by observing what happens when a bottle of soapy water is held up between the eye and a brilliant light. Seen thus the light has a yellow or an orange color, but when the liquid is looked at sideways it appears blue, the rays that have been scattered being thus made visible. When looking up into the sky a similar thing happens, for the blue tint is that which has been scattered from the sunbeams as they splashed, as it were, against the particles of dust suspended in the air.

In the lower strata of the atmosphere the coarser particles of dust not only scatter the waves of light, but they also reflect them, so that at these lower levels the blue tint is diluted by white light, and is accordingly not so intense as when seen, say, from the top of a high mountain. At this elevation only the finer varieties of dust are floating, and there is little reflection of the light, but much scattering, and hence it is here that the blue attains its greatest intensity. In that part of the sky nearest the sun the rays of light come in a direct line to the eye of the observer, and the scattering of the light does not appear so great as when one looks across the path of the beams, and it is due to this circumstance that the sky near the sun is not of so intense a blue as portions of the sky farther away. A similar kind of thing happens in respect of the clouds, where dust readily accumulates, and reflecting the light, produces their brilliant whiteness. At the edges of the clouds, moreover, the atoms of dust are busily engaged in refracting the beams of light, and to this cause is due that brilliant fringe of brightness which so often adorns many of the largest clouds. Not only, therefore, does the atmospheric dust filter out the blue light that tints the sky, but it also fabricates the pigments that color the clouds, effects which can most readily be observed in contemplating the glories of the setting sun.

THE THUNDERSTORM: A NEW EXPLANATION OF ONE OF ITS PHENOMENA.

By Byron McFarland, A.B.

The daily weather maps issued by the United States Weather Bureau show that areas of high pressure, and areas of low pressure—or highs and lows—are continually passing across the continent in a more or less easterly direction. Thunderstorms occur usually in these lows and are therefore called secondary storms, being small, local storms in a large, or general, storm area. These storms furnish the chief supply of rain during the summer months. There can be little doubt but that thunderstorms are composed of rising air and descending air; the air currents blow both *to* and *from* the thunderstorm—both *up* and *down* in it. A peculiar feature of the thunderstorm is the coolness of the air within it. At the storm's arrival the temperature may drop from 10 deg. to 30 deg. F., or even more.

Some of the facts known about thunderstorms are as follows: (*a*) From some distance in front the air blows toward the storm, turns upward as it approaches it, and finally enters the main cloud. (*b*) On the ground below the margin of the cloud the air blows from the cloud; this forms the "squall" or strong cool wind that usually precedes the main storm proper. (*c*) In the center of the storm, the air is more nearly calm than at the border—especially its front border. (*d*) The air pressure is greater in the center of the storm than just in front of the margin of the cloud, i. e., the barometer rises slightly, and generally suddenly, during the passage of the cloud. (*e*) The air in the "squall" is considerably cooler than the surrounding air.

To account for these phenomena of pressure and of air currents (*a-e*) three explanations have been offered: (1) The rain drops falling through the air, push it down and out, thus producing the rise of the barometer and the "squall" below. (2) The warm moist air rising into a region of decreased air pressure, becomes cloud and expands, and in thus pushing aside the surrounding upper air it presses downward with more than its weight, causing at once the slight rise in the barometer at the ground and the outrushing squall. The ascending air produces therefore a sort of recoil comparable to the "kick" of a gun, and this recoil is what "kicks" out the squall below. (3) The rising air above overflows into the neighboring air, and this additional weight produces the increased pressure and the squall below.

(1) The first of these explanations has undoubtedly some foundation in fact, for falling bodies will produce descending currents and lateral winds below. But the fact that the intensity of the squall is not always proportional to the intensity of the rainfall shows that the theory is only a partial explanation of the phenomena in question. (2) The second-named theory is even less tenable. That cloudy air in ascending cools more slowly, and hence expands more rapidly than dry air, is quite true; but this expanding air cannot "kick" a constant squall out of the bottom. I will admit that should a large mass of warm, cloudy air be in some way carried up to the center of the convectional column and there suddenly turned loose, it would expand and increase temporarily the pressure down at the ground. But the thunderstorm is a continuous process of some duration. The following statements appear to me as being in this connection unquestionably true, viz.: (1) the pressure at the ground could not be increased without the pressure above being also and even first increased; (2) the increased pressure at the ground could not be maintained (as it in fact is) unless the increased pressure above be maintained; and (3) if the increased pressure above be maintained, convection would cease, and the thunderstorm would be brought at once to an end.

In my judgment, the only condition under which air can continue to rise for hours into the upper part of the storm is the presence there, not of increased, but of relatively decreased air pressure. The idea that the rising and expanding air above can maintain a constant downward recoil or "kick" sufficient to produce the squall, and at the same time not interfere with the incoming currents above, seems hard to understand. For it could not "kick" at all, unless its pressure be increased; and if its pressure be increased, it would "kick" in all directions, and would "kick" back the incoming currents and prevent them from entering the storm area at all. The surrounding air could not enter until the high pressure had given way to lower pressure; but when this takes place, the high pressure on the ground would also give way to lower pressure, and the squall would cease. But, in fact, both the inflowing currents above and the outrushing squall below blow with comparative uniformity, thus showing that there are some sort of constant barometric conditions established, which insure a low pressure above and a relatively high pressure below.

(3) The "convectional overturn" theory has the same weakness that the "kick" theory has, because (*a*) the upper air could not "overflow" until its pressure be greater than that of the surrounding air; (*b*) if the overflowing air above has relatively greater pressure, it will produce greater pressure below also, unless the column is abnormally warm or light, and we should have the anomaly of air rising into relatively higher pressure and settling in lower pressure.

The explanation which I wish to suggest is based on the well-known coolness of the air in the squall. Under uniform pressure, the density of the air decreases 1/491 of that at 32 deg. F. for every degree Fahrenheit above the freezing point of water.

We will suppose the distance from the thundercloud to the ground to be 1,300 feet (it may be more), and suppose, also, that the air between the cloud and ground is, on an average 15 deg. F. cooler than the surrounding air (it is often considerably more). It may easily be found that the difference in weight of these two columns of air (each 1,300 feet high) would be about 0.04 inch of mercury; that is to say, placed side by side, the cool column would support 0.04 inch more mercury than the warm column would. Evidently, if the air be much cooler (say 35 deg. F.), and if the height of the cool column be several thousand feet, the difference in weight would be much more marked. The presence of this cool column of air, then, extending from the cloud to the ground, will account for the higher air pressure below. But not only this, it will account, also, for the permanent low above. If a series of isobars be drawn in a vertical plane section through the thunderstorm, the isobaric surfaces will crowd together in the cool column and be farther apart in the surrounding region of warm air. The higher pressure below will suffice to produce the squall, and the lower pressure above will permit convection to go on undisturbed.

The rise in barometer during the passage of a thunderstorm is usually very slight. I have often noted, in well-defined storms, a rise of not more than 0.03 inch. In very violent storms, however, the rise may be considerably more, as much as 0.15 or even 0.25 of an inch. But it is a notable fact that in these violent storms, the drop in temperature is very marked. This is just what we should expect if the "cold air" theory is true. I have yet to hear of a thunderstorm accompanied by a typical squall in which the air of the squall was warmer than the surrounding air.

The "cool air" theory will undoubtedly suffice, provided only the cool air column is present. And as indications that the column of cool air does exist, we mention the following: (1) The internal air of the squall is considerably cooler on the ground. (2) The fact that the so-called wind cloud is usually much lower than the other convectional clouds which are fed from air of like temperature and humidity, shows that the rising air meets with relatively cooler air below the margin of the cloud.

There are, of course, several things to be remembered in applying this "cool air" theory. Confessedly there are still a good many "unknowns" in the thunderstorms; but the following will evidently modify and determine the violence of the squall: (1) The average difference of temperature between the cool column and the surrounding air. (2) The height of the cool column. (3) The diameter of the cool column. (4) The progressive motion of the storm itself. No one of these four will alone determine the violence of the squall. In general, the intensity of the squall will vary directly with the relative coolness of the column, its height, and its diameter. But these factors may vary considerably among themselves, and there can be no narrow, cast-iron rules laid down. We should expect to find the squall strongest when these factors combine and weakest when they are weak.

The progressive motion of the storm will affect the squall somewhat, making it apparently stronger in front than behind.

As to the origin of the cold air of the squall there is some diversity of opinion. By some it is thought that the coolness of the air is due to cold rain falling through it. In many cases this seems a sufficient explanation. Thunderclouds probably often extend above the snow line. The melting of this snow, the warming of the cold water in its descent, and the resulting evaporation of some of it, might well keep the air through which it falls several degrees cooler than the outside air. The amount of air that rises into the thunderclouds is apparently several times greater than that which blows out from it below. The falling snow and rain cool a comparatively small amount of air beneath the clouds.

Cool squalls in the absence of rain are thought to be caused by the settling of overlying masses of air that are intrinsically and abnormally cold. This is entirely probable. It is generally supposed that thunderstorms, especially those accompanied by tornadoes, are overlaid by layers of cold air. But it is more probable, I think, that many of the wind clouds, unaccompanied by rain, are the last remnants of former thunderstorms, or are the products of actions that were too feeble to produce a thunderstorm.

It seems pretty certain that the circulation of air in an active or "typical" thunderstorm is about as follows: The air from around rises toward the cloud; the inner layer of this ascending air meeting with the falling snow or rain is cooled, and also pushed down by the rain drops; both cooling and pushing cause it to be turned downward. And as it is more and more cooled (i. e., relatively), and continually beaten down by the falling rain, it settles more and more rapidly, and on reaching the ground becomes the cool out-rushing squall. The presence and the appearance of the so-called "wind cloud" that generally just precedes the rain cloud, seem to indicate this. It is a long light-colored fleecy cloud that suggests a huge roll of wool. A cloud formed at the level where the rising air turns to descend would have an appearance like this.—Monthly Weather Review.

PETRIFIED OAK IN RUSSIA.

A correspondent of the London Builder sends an interesting account of some remarkable deposits of petrified wood existing in one of the rivers of South Russia. The deposit consists of a quantity of calcined oak lying in the bed of the river in layers three or four deep, and extending over an area of some 150 miles. A main feature—which, indeed, constitutes the chief value of this specific hardwood—is its variety of colors. No fewer than twelve shades in pink, blue, yellow, and that known as American walnut have been found. This peculiar formation would seem to have been caused by the variegated character of the soil at the bottom of the river. How long nature has taken to achieve this feat is a question to be solved by geologists. Some six years back a Russian timber merchant purchased a twelve years' lease of the deposits and determined to exploit them. During the six years of his tenancy, already expired, he has nearly doubled the sum of his original outlay, and this with only very primitive methods of exploitation, viz., manual labor with boat-hooks. The excavated timber is in logs of from 12 feet to 200 feet in length by 15 inches to 20 inches in diameter, and each log is of one uniform shade throughout. The transit to St. Petersburg or Riga from the locality of the deposit is comparatively cheap, via Russia's main waterway, the river Volga, and the present leaseholder estimates the deposit as being still capable of yielding from 150,000 to 200,000 good, sound logs of an average length of seventy feet. In the face of the present controversy on the relative values of American timber compared with Australian hardwoods for certain purposes, it would be interesting to know the opinion of the trade upon this Russian deposit of hardwood. It would be still more interesting, from a geological standpoint, to discover whether similar deposits have been known to exist in other parts of the world. That the hardwood may be turned to practical use is evident from the experience of the above-mentioned trader.

DEVELOPMENT OF THE SENSE OF SMELL.

Going one degree further into the infinitesimal, we may learn, by the refined sense of smell, what becomes of matter in the atmosphere when it is so attenuated as fairly to baffle conception. We have abundant evidence of this. The acuteness of the sense of smell among savage tribes is proverbial; but under exceptional circumstances the same sense may become extraordinarily developed in civilized man also. There is a case cited in the "Phil. Trans." of an English woman who, having from an attack of smallpox become not only blind, but also deaf and dumb, conceived a strong aversion to being seen by strangers. It happened that once a friend called, and begged her (by means of a finger alphabet) to come and sit with the rest of the family, assuring her that no strangers were present. Accordingly, the afflicted woman entered the sitting room, but instantly started back and retreated, subsequently declaring—what was indeed the case—that some stranger had just entered the room before her. She had detected this by the sense of smell alone.—The Rev. J. M. Bacon, in The Contemporary Review.

POTASSIUM FROM FELDSPAR.

Mr. J. G. Rhodin, of Manchester, has recently described a method which he has employed for the manufacture on a commercial scale of potassium salts from feldspar. The process consists simply in heating a mixture of the finely ground feldspar with slaked lime and sodium chloride at a temperature of 900 deg. C., whereby from eighty to ninety per cent of the potassium in the mineral is obtained in the form of potassium chloride. The explanation of the reaction which occurs is not yet completely made out, but it seems to be clearly established that a paying yield of potassium chloride can be obtained. The most important question of the supply of material is solved by the fact that immense quantities of this mineral occur in Sweden and Norway, which cannot be used for any other purpose, and already experiments preliminary to the opening of a factory in Sweden have been carried on. A further important feature of the process is that the insoluble matter left after the extraction of the potassium and sodium salts by water forms an excellent material for the manufacture of glass by the addition of a little sand and alkali.—Mining Reporter.

To Waterproof Wide-meshed Fabrics.—The goods, e. g., jute covers, jute packing cloth, etc., are coated with an emulsion and then pressed while hot. The larger the meshes, the thicker must be the emulsion. It consists of cellulose 10 parts, finely powdered asphalt 11 parts, glue 5 parts (dissolved in 50 parts of water), chrome alum 1 part, birch tar oil 8 parts and benzine 16 parts. The coating renders the texture waterproof and at the same time proof to the action of chemicals.—Deutscher Faerber Zeitung.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Proposed Protective Tariff in Great Britain.—Consul McFarland writes from Nottingham, September 11, 1901, in regard to the meeting of the Associated Chambers of Commerce of Great Britain in that city. A resolution advocating the institution of a protective policy by the country was introduced by a Nottingham member, following its adoption by the local association. Earnest attention, says the consul, is being given this subject in trade circles, and there is a desire on the part of British manufacturers to protect themselves against the influx especially of American and German goods. He incloses an extract from a Nottingham paper commenting on the resolution, as follows:

"The British people have lost much of their old admiration for free trade. They see that it works out advantageously for foreign rivals, and as the other nations of the world steadily increase their protective duties, so that there is now not a single foreign market into which British goods can enter freely, a feeling of irritation and annoyance is almost inevitable. . . . We question whether, if it were possible to start afresh, with our present experience as a guide it would be possible to induce the people of this country to adopt free trade in any form. But no one can ever make quite a fresh start. Every person has to bear the consequences of his past actions, and nations in this respect are in the same position as individuals. Since the principle of free trade was deliberately adopted after many years of anxious discussion, a condition of things has grown up which would make it almost impossible to return to protection even if the nation desired it, which at present it does not. Every person who advocates a departure from the principle of free trade is met at the very threshold of his argument by the fact that it is impossible to tax manufactured articles without at the same time taxing food and we do not think that any person now living is likely to see a time when this will be possible. . . . Whether we like it or not, we shall have to go on fighting hostile tariffs with free imports. The struggle is not quite an equal one, and if the British people are to be successful in it, they will have to display a very high degree of intelligence, enterprise, and industry. But the past history of the country shows plainly that hostile tariffs can be fought successfully, and, so far as we can see, there is no reason why this should not continue to be the case."

Chambers of Commerce in Foreign Countries.—The first chamber of commerce founded by one country within the limits of another was in 1870, when Austria established such an institution at Constantinople. At first, this chamber of commerce served the interests of Austria-Hungary politically as well as commercially; to-day, however, it has no claims to a political organization. The home government has always taken an interest in its welfare, and a yearly subsidy is voted by the Reichsrath. The success of the chamber at Constantinople soon led to the establishment of others. In order to hold their own against the competition of England, France, and Germany in the Orient, the merchants of Trieste started a movement which led to the establishment of an Austrian chamber of commerce at Alexandria. This institution gave the merchants of Trieste not only a point of vantage in Egypt, but an observation station as well on the main highway to the Far East. A government subsidy was soon obtained, and other chambers of commerce were established in Paris and London.

In 1872 Great Britain established a chamber of commerce in Paris. This is one of the best-organized chambers in existence, and has served as a model for many others. The most important English firms located in Paris and throughout France are included in its membership. It has rendered important service in establishing satisfactory commercial treaties between France and England, and is in touch with the English importer in Paris and the French Custom House. The merchant in London receives from it all kinds of information in regard to the French market and the French consumer. It enjoys a very high standing in both countries, and the governments look upon it with respect and favor, which can be attributed only to its excellent arrangements. The organization has no official or political character whatever, having been founded entirely through private initiative.

With the exception of the Anglo-American Chamber of Commerce in Brussels, Great Britain has, to my knowledge, no other similar organization on the Continent. She has, however, more than thirty chambers of commerce or boards of trade in her own colonies in every part of the world, all of which belong to, or are members of, the United Chambers of Commerce of the Empire.

The following is a list of the locations of the most important commercial institutions fostered by English and colonial merchants: Aden, Bombay, Buluwayo, Cape Town, Colombo, Constantinople, East London, Freemantle, Georgetown, Grahamstown, Port Alfred, Hobart, Hongkong, Kingston, Madras, Malta, Montreal, Port Elizabeth, Port Louis, Singapore, Sydney, Toronto, Trinidad, and Vancouver.

France has more than thirty chambers of commerce in foreign countries, all of which may be said to have been founded by home chambers. The yearly subvention budget of the French government to-day includes $19,300 for the purpose of helping these useful organizations in Barcelona, Charleroi, Brussels, Lima, London, Constantinople, Mexico, Alexandria, Valparaiso, Port Louis, Galatz, Liverpool, Milan, Montevideo, New Orleans, Rio de Janeiro, Rosario, Caracas, Habana, Montreal, Shanghai, Port Said, Athens, Lisbon, The Hague, Amsterdam, Rotterdam, and Valencia.

These institutions are placed on an equality with the home chambers, with which they maintain regular intercourse. They give information concerning the credit standing of business houses; appoint, when requested, reliable agents; search out new markets, and collect samples of every description for manufacturers at home. The French consul-general or consuls in the above-mentioned cities act as honorary presidents.

The Italian government has always looked favorably upon the founding of chambers of commerce in foreign countries. In 1894 the annual subsidy for this purpose amounted to $31,845. Of this sum, $3,128 went to the support of the chamber in Paris and $2,702 to the one in London. I am not in possession of a complete list of Italian chambers of commerce in foreign countries, but the following are the locations of some of the most important: Paris, London, Constantinople, Tunis, Alexandria, New York, San Francisco, Buenos Ayres, Montevideo, and Rosario.

The Italian chambers do not possess the same character as those of France, for the reason that they are more directly under the supervision of the Minister of Commerce and Industry, who acts as a medium between them and the governments in question respecting subsidies.

According to German press reports, Spain, Greece, and Turkey are considering plans for establishing similar organizations in the most important commercial cities abroad. Belgium has a chamber of commerce in Paris, which issues monthly bulletins pertaining to all matters of commerce and industry.

Germany has a chamber of commerce in Brussels, and, according to recent reports, one will shortly be established at Bucharest, in Roumania. The German merchants of that locality will form the nucleus, receiving assistance from interested firms at home. This chamber will issue reports on the commercial and industrial outlook, not only in Roumania, but in the entire Levant. It will serve as a link to connect German business men in that part of the world with manufacturers and merchants at home. Last fall the subject of establishing German chambers of commerce in foreign countries was discussed in the Reichstag, but without result. The question is being continually agitated by different commercial bodies in this Empire, and press reports are altogether favorable to the plan in general. As far back as 1888, the Chamber of Commerce of Mannheim sent a memorial on the subject to the Imperial Minister of the Interior, setting forth that, in the opinion of that body, nothing could be more instrumental in furthering the interests of Germany's foreign commerce than the establishment of such institutions abroad. No less than forty-eight German chambers of commerce at once set their signatures to the Mannheim petition. It must be borne in mind that these bodies in Germany, unlike those in England and America, receive State aid, and in the movement to found similar institutions in foreign countries, it is taken for granted that they will be organized like those of France or Italy and subsidized by the government. This pecuniary point, at a time when the nation is confronted by new tariff plans for raising revenue, together with the disbursements created by the recent naval appropriations and the general industrial depression all over the Empire, will probably prevent any definite steps being taken in the matter for years to come. In the meantime, German merchants located in foreign business centers are likely to take the matter in hand and follow the lead of England and America, organizing chambers of commerce through private enterprise, which will have no connection whatever with the home government.

The German Chamber of Commerce in Brussels has accomplished much for the commercial interests of the Empire. In 1895, one year after its foundation, this chamber made its influence felt during the introduction and passage of the Belgian tariff law of that year. In addition to the general duties of such an organization, it takes an active interest in the complaints of German merchants located in Belgium, and advocates their interests before the proper authorities.

The United States has thus far three chambers of commerce abroad, namely, in Paris, Brussels, and Manila. The chamber in Paris (No. 3, Rue Scribe) was founded in 1896 by American merchants resident in that city. In 1900 it had 201 paid-up memberships, of which 145 were American and 56 foreign. Its finances are well organized, and a fund has been established which, in time, will be devoted to the construction of a permanent home for the institution. The chamber has for its object "to examine questions concerning the commercial and industrial relations between the United States and France; to protect the mercantile interests subsisting between individuals and firms in the two aforesaid countries, and to take all measures which may facilitate and protect the transactions of business between them." The annual membership dues are 100 francs ($19.30). In its reading room are found all the leading American trade papers, while the library consists of over 700 well-chosen volumes relating to commerce and industry.

The Anglo-American Chamber in Brussels (29 Boulevard Anspach) was established in 1898 by English and American business men located in that city and in Antwerp, for the purpose of "promoting measures calculated to benefit, protect, and forward the mercantile and trading interests of its members in Belgium; to represent and express their sentiments on commercial affairs; to collect statistics bearing upon the trade and manufactures of Great Britain and the United States of America; to establish a commercial library and a museum of samples in Brussels; to attain such other objects of general commercial advantage as the exertions of individuals may be less able to accomplish; to do all such other things as are incidental or conducive to the attainment of the above objects, or any of them." It is a flourishing institution, with over 200 members.

The best argument in favor of founding American chambers of commerce in foreign countries is the success which is attending the efforts of those already in existence. The importance of this subject in general is such that I would recommend it to the careful consideration of our chambers of commerce, manufacturers, and merchants who are interested in the export of American products to every part of the world. These useful institutions established in emporiums of trade such as London, Moscow, Yokohama, Shanghai, Sydney, Cape Town, Buenos Ayres, and some good city in the German Empire, would be strategic points of immense advantage in furthering the expansion of American commerce.—Ernest L. Harris, Consular Agent at Eibenstock.

Agricultural Machinery in Germany.—In making a short tour of inspection through the extreme western end of this consular district—between the Duchy of Saxe-Meiningen and Bavaria—a part of the country entirely devoted to agriculture, with exceedingly rich soil, I was surprised to see the old-fashioned implements employed in cultivation. Modern farm machinery was used in very few instances, and as a rule the so-called improved tools were German imitations of American machines. The people in these rich valleys are mostly well-to-do, and if modern machinery were properly introduced by a canvass from village to village, on the part of able salesmen who could speak the German language, a capital opening for our improved agricultural machines and implements could be secured. Nothing can be gained, however, by sending catalogues printed in English. There are many small cities and towns scattered through these farming lands—Neubrünn, Ritschenhausen, Nordheim, Berkach, Hollstadt, Münnerstadt, Grosswenkheim, Neustadt an der Saale, Bad Neuhaus, etc.—directly on or close to the railroad between Meiningen and Schweinfurt. They could be visited one after another; the late fall months or the early winter ones would be the best time. If our exporters wish to take advantage of this report, they should do so at once; otherwise foreign manufacturers, many of whom read our Consular Reports, are apt to step in and reap the benefits.—Oliver J. D. Hughes, Consul-General at Coburg.

Trade of La Paz, Bolivia.—Vice-Consul-General Murphy, of Frankfort, sends a translation from the Berlin Suedamerikanische Rundschau, as follows:

"The German consul at La Paz reports that Germany holds the first place, as far as importations into Bolivia through La Paz are concerned, in deliveries of woolens and silks, iron wares, clothing, knitted wares, and furniture. France leads in the importation of wines and liquors, owing to the fact that it has for years had a commercial treaty with Bolivia under which French wines are admitted free of duty.* If the United States is first in the importation of cotton wares, this is due to the fact that it supplies a much-used article, gray shirting, which even Manchester cannot manufacture so cheaply. Germany takes the second place in cotton wares, while England comes third. An important article of importation from Germany is machinery for mines and smelting works. The entire material for the water works of the city of Oruro was brought from Germany. Cannon and rifles were also supplied by Germany through English firms. Narrow-gage railways are mostly of German origin.

"Concerning exportations from the department of La Paz, no statistics are available. The principal export article was rubber. In smaller quantities cinchona bark and tin ore were also exported. From Corocoro important quantities of very rich copper ore are sent to England. The departments of Oruro and Potosi export much tin and silver ore, the business being chiefly in German hands. The richest tin ore in the world comes from Bolivia, but many of the mines are in the hands of persons of small means, whose capital is not sufficient to render possible a profitable exploitation of the property. The United States and England are doing their utmost to get the rich mines into their hands and are constantly sending, at great expense, experts to Bolivia to study the country. Sooner or later they will get possession of the best mining lands.

"The quality of Bolivian rubber is excellent, and this rubber commands almost the same price as that of Para, which is not to be wondered at, as the Bolivian tree does not differ from that found in the Amazon Valley. The production is, however, unfavorably affected by the lack of laborers and insufficient facilities for transportation."

Notes from Nicaragua.—The following has been received from Consular Agent Manning, of Matagalpa:

I would call the attention of our exporters to certain things that have come under my observation. The principal merchants here are European, but the large American colony has demanded that they import certain United States goods, wishing better quality than is usual in European articles of the same class. To satisfy this demand one of the heaviest importers here sent a trial order to a house in San Francisco. Imagine his surprise to find that a number of the articles shipped him bore such mottoes as "Made in Germany," "Made in France," "All English labor employed," etc. This importer is an Englishman, and imports everything he can from England and many things from Germany and France direct, and these same articles would have come to him in this way, less American duties and other charges, therefore much more cheaply. Among the goods were corkscrews, screw drivers, pocketknives, scissors, etc. I think our wholesalers should understand that when orders are sent from Spanish America it is with a view to securing United States articles. If Nicaragua duties on ready-made clothing and boots and shoes were reduced a new trade would be opened with this country, where such things are absolutely not to be had.

* Since the report quoted above was written, notice has been given which will terminate in May, 1902, the commercial convention of September 15, 1892, between Bolivia and France. French wine will then be subject to the same duty as that from other countries.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECEIPTS.

Production of Patina on Bronze.—For the production of patina on bronze dissolve copper nitrate 10 and kitchen salt 2 in 0.5 liter of water and add a solution of ammonium acetate obtained by neutralization of 10 of officinal spirit of sal-ammoniac with acetic acid to a faintly acid reaction, and filling up with water to 0.5 liter. Immerse the bronze, allow to dry, brush off superficially and repeat this until the desired shade of color has been obtained.—Journal der Goldschmiedekunst.

Cement for Mending Celluloid and Hard Rubber.—For celluloid goods prepare a cement by dissolving 1 part of camphor in 4 parts of alcohol and adding an equal amount of shellac to the camphor solution. The cement must be applied hot.

For hard rubber articles use a melted mixture of gutta percha and genuine asphalt, which is likewise applied hot. The celluloid, as well as the hard rubber goods, must be kept pressed together until the cement has cooled.—Deutsche Maler Zeitung.

Peau d'Espagne.—

Opoponax oil	5 grammes
Rose oil	10 drops
Musk tincture	6 grammes
Heliotrope extract	200 grammes
Cassia oil	3 grammes
Orris root tincture, 1 in 10	100 grammes
Amber tincture	8 grammes
Spirit of wine, 80 per cent	540 grammes

—Seifensieder Zeitung, Augsburg.

Production of Powdered Blood.—In order to concentrate the large quantities of blood which are obtained as waste at the slaughter houses in an economic manner, H. Vollberg, of Berlin, has devised a process, which may also be applied to other liquids, especially milk. It consists in that the blood is blown in a finely divided state by means of air pressure through atomizing nozzles into a stave-shaped space open at the top. It is placed in contact with a hot air current rising from below, so that on the one hand the water contained in the blood evaporates fully, while, on the other hand the resulting blood powder is borne into a receiver. The process is said to be very cheap and operates quickly. According to the inventor, the blood powder thus obtained contains 74.8 per cent of digestible albumen and is perfectly tasteless.—Technische Runschau.

Jaborandi Scalp-water for Increasing the Growth of Hair.—First prepare a jaborandi tincture from jaborandi leaves 200 grammes, spirit (95 per cent) 700 grammes and water 300 grammes. After digesting for a week, squeeze out the leaves and filter the liquid. The hair wash is now prepared as follows:

1. Jaborandi tincture, 1,000 grammes; spirit, 95 per cent, 700 grammes; water, 300 grammes; glycerin, 150 grammes; scent essence, 100 grammes; color with sugar color.

2. Jaborandi tincture, 1,000 grammes; spirit (95 per cent), 1,500 grammes; quinine tannate, 4 grammes; Peru balsam, 20 grammes; essence heliotrope, 50 grammes. Dissolve the quinine and the Peru balsam in the spirit and then add the jaborandi tincture and the heliotrope essence. Filter after a week. Rub into the scalp twice a week before retiring.—Der Deutsche Parfumeur.

Imitation of Walnut Grain.—In order to obtain a faultless imitation of the veining of walnut, the article to be stained is, after having been neatly rubbed down without oil, dabbed with a sponge charged with potassium permanganate and squeezed out again until rather dry. The sponge is best seized in a handle like wooden shell or similar object, in order to protect the hands, which are dyed brown by the potassium permanganate. The dabbing must, however, only be carried to such an extent that plenty of white spots remain between the brown dabs. Next saturate with alkanna root oil and polish lightly. When this is done dab again with a well-squeezed-out sponge, which this time is not saturated as previously with potassium permanganate, but with a filtered solution of best Bismarck brown in spirit. When the article has dried for a short time the polishing process is continued carefully, constantly sprinkling on a little pumice stone, so as to obtain a nice, smooth surface. After each polishing operation dab the necessary places as previously explained. Owing to the dabs only covering partially, a handsome graining is produced. With a little practice the work proceeds quickly and smoothly.—Maler Zeitung.

Treatment and Utilization of Rubber Scraps.—The trade in rubber waste, which only twenty years ago was considered worthless, has assumed relative importance. Very essential is a careful and proper assorting of the material, whereby only it receives its true value.

The scraps assorted according to their composition are first cleaned by boiling to remove the adhering dirt, absorbed and adhering acids, salts, etc., as well to eliminate the free sulphur. Attempts to desulphurize the vulcanized rubber, and to obtain the free rubber from it after removal of the admixed ingredients, have up to the present not been successful. Next, the waste is ground between rollers and reduced to powder in emery grinders with automatic feeding. In many cases the material obtained may be added at once dry to the mixture, but generally it first receives a chemical treatment. This is carried out by boiling in caustic soda solution, or sulphuric or hydrochloric acid respectively and steaming for about 20 hours with four atmospheres pressure.

According to another method, the ground scraps are steamed with soda lye under pressure, washed twice thoroughly for the elimination of the lye and dried in the vacuum. Subsequently mix between cold rollers with 5 to 10 per cent of benzol or mineral oil and steam for some hours under hydraulic pressure at four atmospheres.

The product thus obtained is rolled in plates and added to the mixture. The finely ground dry waste must not be stored for a long time in large quantities, as it hardens very easily and takes fire.—Gummi Zeitung.

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